



# THE KAVERY ENGINEERING COLLEGE

(An Autonomous Institution)

Mecheri, Salem - 636 453.



Approved by AICTE, New Delhi  
Affiliated to Anna University

## DEPARTMENT OF MECHANICAL ENGINEERING

M.E - Industrial Safety and Engineering



AUTONOMOUS  
CURRICULUM AND

PG  
REGULATIONS

# 2024

Academic Year 2026 - 27 onwards

SYLLABUS

# I-IV

SEMESTERS



# The Kavery Engineering College



Mecheri, Mettur Tk. Salem Dt – 636 453.

(An Autonomous Institution Approved by AICTE, New Delhi & Affiliated to Anna University)

An ISO 9001:2015 certified Institution and accredited by NAAC with A+ grade.

## REGULATIONS - 2024

### CHOICE BASED CREDIT SYSTEM

#### M.E. PRODUCT DESIGN AND DEVELOPMENT

#### CURRICULUM & SYLLABI FOR I TO IV SEMESTERS

(For the students admitted 2024 onwards)

| SEMESTER – I                          |                                            |              |   |   |        |               |     |       |          |
|---------------------------------------|--------------------------------------------|--------------|---|---|--------|---------------|-----|-------|----------|
| Course Code                           | Course Title                               | Hours / Week |   |   | Credit | Maximum Marks |     |       | Category |
|                                       |                                            | L            | T | P |        | CA            | ESE | Total |          |
| Theory                                |                                            |              |   |   |        |               |     |       |          |
| PPDT2411                              | Computer Applications In Design            | 3            | 0 | 0 | 3      | 40            | 60  | 100   | PCC      |
| PPDT2412                              | Reverse Engineering                        | 3            | 0 | 0 | 3      | 40            | 60  | 100   | PCC      |
| PPDT2413                              | Creativity and Innovation                  | 3            | 0 | 0 | 3      | 40            | 60  | 100   | PCC      |
| PPDT2414                              | Integrated Product Development             | 3            | 0 | 0 | 3      | 40            | 60  | 100   | PCC      |
| PRMT2411                              | Research Methodology and IPR               | 2            | 0 | 0 | 2      | 40            | 60  | 100   | RMC      |
|                                       | Professional Elective - I                  | 3            | 0 | 0 | 3      | 40            | 60  | 100   | PEC      |
|                                       | Audit Course - I*                          | 2            | 0 | 0 | 0      |               |     |       | AC       |
| Practical / Employability Enhancement |                                            |              |   |   |        |               |     |       |          |
| PPDL2411                              | Cad Laboratory and Multi body Dynamics Lab | 0            | 0 | 4 | 2      | 60            | 40  | 100   | PCC      |
| PPDL2412                              | Reverse Engineering Laboratory             | 0            | 0 | 4 | 2      | 60            | 40  | 100   | PCC      |
| Total Credits to be earned            |                                            |              |   |   | 21     |               |     |       |          |

\$ Skill Based Course

| SEMESTER – II                         |                                             |              |   |   |        |               |     |       |          |
|---------------------------------------|---------------------------------------------|--------------|---|---|--------|---------------|-----|-------|----------|
| Course Code                           | Course Title                                | Hours / Week |   |   | Credit | Maximum Marks |     |       | Category |
|                                       |                                             | L            | T | P |        | CA            | ESE | Total |          |
| Theory                                |                                             |              |   |   |        |               |     |       |          |
| PPDT2421                              | Finite Element Methods in Mechanical Design | 3            | 1 | 0 | 4      | 40            | 60  | 100   | PCC      |
| PPDT2422                              | Designing with Advanced Materials           | 3            | 0 | 0 | 3      | 40            | 60  | 100   | PCC      |
| PPDT2423                              | Solid Freeform Manufacturing                | 3            | 0 | 0 | 3      | 40            | 60  | 100   | PCC      |
| PPDT2424                              | Design for Manufacture and Assembly         | 3            | 0 | 0 | 3      | 40            | 60  | 100   | PCC      |
| PPDT2425                              | Concepts of Engineering Design              | 3            | 0 | 0 | 3      | 50            | 50  | 100   | PEC      |
|                                       | Professional Elective - II                  | 3            | 0 | 0 | 3      | 40            | 60  | 100   | PEC      |
|                                       | Audit Course - II*                          | 2            | 0 | 0 | 2      |               |     |       | AC       |
| Practical / Employability Enhancement |                                             |              |   |   |        |               |     |       |          |
| PPDL2421                              | Advanced Analysis and Simulation Laboratory | 0            | 0 | 4 | 2      | 60            | 40  | 100   | PCC      |
| PPDL2422                              | Product Design Laboratory                   | 0            | 0 | 4 | 2      | 60            | 40  | 100   | PCC      |
| Total Credits to be earned            |                                             |              |   |   | 23     |               |     |       |          |

| SEMESTER – III                        |                              |              |   |    |        |               |     |       |          |
|---------------------------------------|------------------------------|--------------|---|----|--------|---------------|-----|-------|----------|
| Course Code                           | Course Title                 | Hours / Week |   |    | Credit | Maximum Marks |     |       | Category |
|                                       |                              | L            | T | P  |        | CA            | ESE | Total |          |
| Theory                                |                              |              |   |    |        |               |     |       |          |
| PPDT2431                              | Product Lifecycle Management | 3            | 0 | 0  | 3      | 40            | 60  | 100   | PCC      |
|                                       | Professional Elective - III  | 3            | 0 | 0  | 3      | 40            | 60  | 100   | PEC      |
|                                       | Professional Elective - IV   | 3            | 0 | 0  | 3      | 40            | 60  | 100   | PEC      |
|                                       | Open Elective                | 3            | 0 | 0  | 3      | 40            | 60  | 100   | OEC      |
| Practical / Employability Enhancement |                              |              |   |    |        |               |     |       |          |
| PPDL2431                              | Project Work I               | 0            | 0 | 12 | 6      | 40            | 60  | 100   | EEC      |
| PPDL2432                              | Summer Internship #          | 0            | 0 | 1  | 1      | 0             | 100 | 100   | EEC      |
| Total Credits to be earned            |                              |              |   |    | 19     |               |     |       |          |

# Two weeks summer internship carries one credit and it will be done during II semester summer vacation.

| SEMESTER – IV                         |                 |              |   |   |        |               |     |       |          |
|---------------------------------------|-----------------|--------------|---|---|--------|---------------|-----|-------|----------|
| Course Code                           | Course Title    | Hours / Week |   |   | Credit | Maximum Marks |     |       | Category |
|                                       |                 | L            | T | P |        | CA            | ESE | Total |          |
| Practical / Employability Enhancement |                 |              |   |   |        |               |     |       |          |
| PPDL2441                              | Project Work II | 0            | 0 | 0 | 12     | 40            | 60  | 100   | EEC      |
| Total Credits to be earned            |                 |              |   |   | 12     |               |     |       |          |

**TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE:75**

| PROFESSIONAL CORE COURSES (PCC) |                                                  |          |                |   |   |   |               |    |       |
|---------------------------------|--------------------------------------------------|----------|----------------|---|---|---|---------------|----|-------|
| Course Code                     | Course Name                                      | Category | Periods / Week |   |   | C | Maximum Marks |    |       |
|                                 |                                                  |          | L              | T | P |   | CA            | FE | Total |
| PPDT2411                        | Computer Applications in Design                  | PCC      | 3              | 0 | 0 | 3 | 40            | 60 | 100   |
| PPDT2412                        | Reverse Engineering                              | PCC      | 3              | 0 | 0 | 3 | 40            | 60 | 100   |
| PPDT2413                        | Creativity and Innovation                        | PCC      | 3              | 0 | 0 | 3 | 40            | 60 | 100   |
| PPDT2414                        | Integrated Product Development                   | PCC      | 3              | 0 | 0 | 3 | 40            | 60 | 100   |
| PPDL2411                        | CAD Laboratory and Multibody Dynamics Laboratory | PCC      | 0              | 0 | 4 | 2 | 40            | 60 | 100   |
| PPDL2412                        | Reverse Engineering Laboratory                   | PCC      | 0              | 0 | 4 | 2 | 40            | 60 | 100   |
| PPDT2421                        | Finite Element Methods in Mechanical Design      | PCC      | 3              | 1 | 0 | 4 | 40            | 60 | 100   |
| PPDT2422                        | Designing with Advanced Materials                | PCC      | 3              | 0 | 0 | 3 | 40            | 60 | 100   |
| PPDT2423                        | Solid Freeform Manufacturing                     | PCC      | 3              | 0 | 0 | 3 | 40            | 60 | 100   |
| PPDT2424                        | Design for Manufacture and Assembly              | PCC      | 3              | 0 | 0 | 3 | 40            | 60 | 100   |
| PPDL2421                        | Advanced Analysis and Simulation Laboratory      | PCC      | 0              | 0 | 4 | 2 | 40            | 60 | 100   |
| PPDL2422                        | Product Design Laboratory                        | PCC      | 0              | 0 | 4 | 2 | 40            | 60 | 100   |
| PPDT2431                        | Product Lifecycle Management                     | PCC      | 3              | 0 | 0 | 3 | 40            | 60 | 100   |
| PROFESSIONAL ELECTIVES (PE)     |                                                  |          |                |   |   |   |               |    |       |
| SEMESTER I, ELECTIVE I          |                                                  |          |                |   |   |   |               |    |       |
| PPDE2401                        | Tribology in Design                              | PEC      | 3              | 0 | 0 | 3 | 40            | 60 | 100   |
| PPDE2402                        | Advanced Machine Tool Design                     | PEC      | 3              | 0 | 0 | 3 | 40            | 60 | 100   |
| PPDE2403                        | Generative Design and Topology Optimization      | PEC      | 3              | 0 | 0 | 3 | 40            | 60 | 100   |

|                                                                      |                                                        |     |   |   |    |    |    |     |     |
|----------------------------------------------------------------------|--------------------------------------------------------|-----|---|---|----|----|----|-----|-----|
| PPDE2404                                                             | Data Analytics                                         | PEC | 3 | 0 | 0  | 3  | 40 | 60  | 100 |
| <b>SEMESTER II, ELECTIVE II</b>                                      |                                                        |     |   |   |    |    |    |     |     |
| PPDE2405                                                             | Industrial Robotics and Expert Systems                 | PEC | 3 | 0 | 0  | 3  | 40 | 60  | 100 |
| PPDE2406                                                             | Engineering Fracture Mechanics                         | PEC | 3 | 0 | 0  | 3  | 50 | 50  | 100 |
| PPDE2407                                                             | Enterprise Resource Planning and Management            | PEC | 3 | 0 | 0  | 3  | 50 | 50  | 100 |
| PPDE2408                                                             | Artificial Intelligence and Machine Learning           | PEC | 3 | 0 | 0  | 3  | 40 | 60  | 100 |
| PPDE2409                                                             | Design for Additive Manufacturing                      | PEC | 3 | 0 | 0  | 3  | 40 | 60  | 100 |
| <b>SEMESTER III, ELECTIVE III</b>                                    |                                                        |     |   |   |    |    |    |     |     |
| PPDE2410                                                             | Quality and Financial Concepts in Product Development. | PEC | 3 | 0 | 0  | 3  | 40 | 60  | 100 |
| PPDE2411                                                             | Optimization Techniques in Design                      | PEC | 3 | 0 | 0  | 3  | 40 | 60  | 100 |
| PPDE2412                                                             | Vibration Analysis and Control                         | PEC | 3 | 0 | 0  | 3  | 40 | 60  | 100 |
| PPDE2413                                                             | IOT Technologies                                       | PEC | 3 | 0 | 0  | 3  | 40 | 60  | 100 |
| PPDE2414                                                             | Computational Fluid Dynamics                           | PEC | 3 | 0 | 0  | 3  | 40 | 60  | 100 |
| <b>SEMESTER III, ELECTIVE IV</b>                                     |                                                        |     |   |   |    |    |    |     |     |
| PPDE2415                                                             | Human Factors Engineering in Product Design            | PEC | 3 | 0 | 0  | 3  | 40 | 60  | 100 |
| PPDE2416                                                             | Design of Hybrid and Electric Vehicles                 | PEC | 3 | 0 | 0  | 3  | 40 | 60  | 100 |
| PPDE2417                                                             | Rotor Dynamics                                         | PEC | 3 | 0 | 0  | 3  | 40 | 60  | 100 |
| PPDE2418                                                             | Bio materials                                          | PEC | 3 | 0 | 0  | 3  | 40 | 60  | 100 |
| <b>EMPLOYABILITY ENHANCEMENT COURSES (EEC)</b>                       |                                                        |     |   |   |    |    |    |     |     |
| PPDL2431                                                             | Project Work I                                         | EEC | 0 | 0 | 12 | 6  | 40 | 60  | 100 |
| PPDL2441                                                             | Project Work II                                        | EEC | 0 | 0 | 24 | 12 | 80 | 120 | 200 |
| <b>AUDIT COURSES (AC)</b>                                            |                                                        |     |   |   |    |    |    |     |     |
| <b>Registration for any of these courses is optional to students</b> |                                                        |     |   |   |    |    |    |     |     |
| PAXC2401                                                             | English for Research Paper Writing                     |     | 2 | 0 | 0  | 0  |    |     |     |
| PAXC2402                                                             | Disaster Management                                    |     | 2 | 0 | 0  | 0  |    |     |     |
| PAXC2403                                                             | Constitution of India                                  |     | 2 | 0 | 0  | 0  |    |     |     |
| PAXC2404                                                             | நற்றமிழ் இலக்கியம்                                     |     | 2 | 0 | 0  | 0  |    |     |     |

| OPEN ELECTIVE COURSES (For Other Branches) |                                                        |          |                |   |   |   |               |    |       |
|--------------------------------------------|--------------------------------------------------------|----------|----------------|---|---|---|---------------|----|-------|
| Course Code                                | Course Name                                            | Category | Periods / Week |   |   | C | Maximum Marks |    |       |
|                                            |                                                        |          | L              | T | P |   | CA            | FE | Total |
| PPOE2401                                   | Vibration and Noise Control Strategies                 |          | 3              | 0 | 0 | 3 | 40            | 60 | 100   |
| PPOE2402                                   | Energy Conservation and Management in Domestic Sectors |          | 3              | 0 | 0 | 3 | 40            | 60 | 100   |
| PPOE2403                                   | Additive Manufacturing                                 |          | 3              | 0 | 0 | 3 | 40            | 60 | 100   |
| PPOE2404                                   | Electric Vehicle Technology                            |          | 3              | 0 | 0 | 3 | 40            | 60 | 100   |
| PPOE2405                                   | New Product Development                                |          | 3              | 0 | 0 | 3 | 40            | 60 | 100   |

### SUMMARY

| M.E. PRODUCT DESIGN AND DEVELOPMENT |                        |                      |           |           |           |  |  |  |  |               |              |
|-------------------------------------|------------------------|----------------------|-----------|-----------|-----------|--|--|--|--|---------------|--------------|
| S. No                               | Subject Area           | Credits per Semester |           |           |           |  |  |  |  | Total Credits | Credits in % |
|                                     |                        | I                    | II        | III       | IV        |  |  |  |  |               |              |
| 1                                   | PCC                    | 16                   | 17        | 3         |           |  |  |  |  | 36            | 48.00%       |
| 2                                   | RMC                    | 2                    | 6         |           |           |  |  |  |  | 8             | 10.66%       |
| 3                                   | PEC                    | 3                    |           | 6         |           |  |  |  |  | 9             | 12.00%       |
| 4                                   | OEC                    |                      |           | 3         |           |  |  |  |  | 3             | 4.00%        |
| 5                                   | EEC                    |                      |           | 7         | 12        |  |  |  |  | 19            | 25.33%       |
| 8                                   | Non-Credit / Mandatory | √                    | √         |           |           |  |  |  |  |               | 0.00%        |
| <b>Total</b>                        |                        | <b>21</b>            | <b>23</b> | <b>19</b> | <b>12</b> |  |  |  |  | <b>75</b>     | <b>100%</b>  |

RMC –

PCC – Professional Core Courses

PEC – Professional Elective Courses

OEC – Open Elective Courses

EEC – Employment Enhancement Course

AC – Audit Course

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|--------|
| PPDT2411                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | COMPUTER APPLICATIONS IN DESIGN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | PCC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <ul style="list-style-type: none"><li>To understand fundamental concepts of computer graphics and its tools in a generic framework.</li><li>To impart the parametric fundamentals to create and manipulate geometric models using Curves, surfaces and solids.</li><li>To impart the parametric fundamentals to create and manipulate geometric models using NURBS and solids.</li><li>To provide clear understanding of CAD systems for 3D modeling and viewing.</li><li>To create strong skills of assembly modeling and prepare the student to be an effective user of a standards in CAD system.</li></ul> |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |   |   | 9      |
| Overview of Graphics systems: Video Display Devices, Raster-Scan System, Random-Scan Systems, Graphics Monitors and Workstations, Input Devices, Hard-Copy Devices, Graphics Software. Output primitives: Line Drawing Algorithm - DDA, Bresenham’s and Parallel Line Algorithm. Circle generating algorithm – Midpoint Circle Algorithm. Geometric Transformations: Coordinate Transformations, Windowing and Clipping, 2D Geometric transformations- Translation, Scaling, Shearing, Rotation and Reflection, Composite transformation, 3D transformations. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | CURVES AND SURFACES MODELLING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |   |   | 9      |
| Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline- Bezier curve and B - Spline curve – curve manipulations. Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated cylinder – synthetic surfaces: Hermitebicubic surface- Bezier surface and B- Spline surface- surface manipulations.                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | NURBS AND SOLID MODELING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |   |   | 9      |
| NURBS- Basics- curves, lines, arcs, circle and bi linear surface. Regularized Boolean set operations - primitive instancing - sweep representations - boundary representations – constructive solid Geometry - comparison of representations - user interface for solid modeling.                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | VISUAL REALISM                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |   |   | 9      |
| Hidden Line removal, Hidden Surface removal, – Hidden Solid Removal algorithms - Shading – Coloring. Animation - Conventional, Computer animation, Engineering animation - types and techniques.                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | ASSEMBLY OF PARTS AND PRODUCT LIFE CYCLE MANAGEMENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |   |   | 9      |
| Assembly modeling – Design for manufacture – Design for assembly – computer aided DFMA - inferences of positions and orientation - tolerances analysis –Center of Gravity and mass property calculations - mechanism simulation. Graphics and computing standards - Data Exchange standards. Product development and management – new product development –models utilized in various phases of new product development – managing product life cycle.                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Boothroyd, G, “Assembly Automation and Product Design” Marcel Dekker, New York, 1997.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | hitale A.K and Gupta R.C “ Product design and manufacturing “ PHI learning private limited, 6th Edition, 2015.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |   |   |        |

| <b>REFERENCES:</b> |                                                                                                                                          |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| 1.                 | David Rogers, James Alan Adams “Mathematical Elements for Computer Graphics” 2 <sup>nd</sup> Edition, Tata McGraw-Hill edition.2003      |
| 2.                 | Donald D Hearn and M. Pauline Baker “Computer Graphics C Version”, Prentice Hall, Inc.,2 <sup>nd</sup> Edition, 1996.                    |
| 3.                 | Ibrahim Zeid, "Mastering CAD/CAM", McGraw Hill, 2 <sup>nd</sup> Edition, 2006                                                            |
| 4.                 | William M Newman and Robert F.Sproull “Principles of Interactive Computer Graphics”, McGraw Hill Book Co. 1 <sup>st</sup> Edition, 2001. |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                                                                                   |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                          | Solve 2D and 3D transformations for the basic entities like line and circle.                                      |     |     |     |     |     |     |     |     |      |      | Analyzing                    |      |      |
| CO2:                                                                          | Formulate the basic mathematics fundamental to CAD system.                                                        |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO3:                                                                          | Use the different geometric modeling techniques like feature based modeling, surface modeling and solid modeling. |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO4:                                                                          | Create geometric models through animation and transform them into real world systems                              |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| CO5:                                                                          | Simulate assembly of parts using Computer-Aided Design software.                                                  |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| Mapping of COs with POs and PSOs                                              |                                                                                                                   |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/POs                                                                       | PO1                                                                                                               | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                           | 1                                                                                                                 | 2   | 1   | 3   | 3   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                           | 1                                                                                                                 | 2   | 1   | 3   | 3   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                           | 1                                                                                                                 | 2   | 1   | 3   | 3   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                           | 1                                                                                                                 | 2   | 1   | 3   | 3   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                           | 1                                                                                                                 | 2   | 1   | 3   | 3   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                          | 1                                                                                                                 | 2   | 1   | 3   | 3   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial , BT – Bloom’s Taxonomy             |                                                                                                                   |     |     |     |     |     |     |     |     |      |      |                              |      |      |

|                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|---|--------|
| PPDT2412                                                                                                                                                                                                                                   | REVERSE ENGINEERING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   |        |
|                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | PCC      | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
|                                                                                                                                                                                                                                            | <ul style="list-style-type: none"><li>Applying the fundamental concepts and principles of reverse engineering in product design and development.</li><li>Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.</li><li>Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.</li><li>Applying the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.</li><li>Analyzing the various legal aspect and applications of reverse engineering in product design and development.</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                   | INTRODUCTION TO REVERSE ENGINEERING & GEOMETRIC FORM                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |   |   |   | 9      |
| Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                  | MATERIAL CHARACTERISTICS, PART DURABILITY AND LIFE LIMITATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |          |   |   |   | 9      |
| Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                 | MATERIAL IDENTIFICATION AND PROCESS de VERIFICATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   | 9      |
| Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                  | DATA PROCESSING, PART PERFORMANCE AND SYSTEM COMPATIBILITY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   | 9      |
| Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                   | ACCEPTANCE, LEGALITY AND INDUSTRIAL APPLICATIONS OF RE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |   |   |   | 9      |
| Legality of Reverse Engineering – Patent – Copyrights –Trade Secret – Third-Party Materials – Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry.                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                         | <b>"Practical Reverse Engineering"</b> by Bruce Dang, Alexandre Gazet, and Elias Bachaalany <ul style="list-style-type: none"><li>This book is great for learning reverse engineering techniques for both software and hardware, using examples such as x86/x64 assembly and modern reverse engineering tools.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                         | <b>"Reverse Engineering: Mechanisms, Structures, Systems &amp; Materials"</b> by V. P. Astakhov <ul style="list-style-type: none"><li>This is more focused on reverse engineering for mechanical systems, materials, and structures.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                         | 1. Co-ordinate Measurement and reverse engineering, Donald R. Honsa, ISBN 1555897, American Gear Manufacturers Association                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                         | Data Reverse Engineering, Aiken, Peter, McGraw-Hill, 1996                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| 3.                                                                                                                                                                                                                                         | Design Recovery for Maintenance and Reuse, T J Biggerstaff, IEEE Corpn. July 1991                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |   |   |   |        |

|                                                                                               |                                                                                                                                                          |     |     |     |     |     |     |     |     |      |      |                                  |      |      |
|-----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|----------------------------------|------|------|
| 4.                                                                                            | Reverse Engineering, Katheryn, A. Ingle, McGraw-Hill, 1994                                                                                               |     |     |     |     |     |     |     |     |      |      |                                  |      |      |
| 5.                                                                                            | Reverse Engineering, Linda Wills, Kluiver Academic Publishers, 1996                                                                                      |     |     |     |     |     |     |     |     |      |      |                                  |      |      |
| 6.                                                                                            | White paper on RE, S. Rugaban, Technical Report, Georgia Instt. of Technology, 1994                                                                      |     |     |     |     |     |     |     |     |      |      |                                  |      |      |
| <b>COURSE OUTCOMES:</b><br><b>Upon completion of the course, the students will be able to</b> |                                                                                                                                                          |     |     |     |     |     |     |     |     |      |      | <b>BT Mapped (Highest Level)</b> |      |      |
| CO1:                                                                                          | Apply the fundamental concepts and principles of reverse engineering in product design and development.                                                  |     |     |     |     |     |     |     |     |      |      | Applying                         |      |      |
| CO2:                                                                                          | Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development. |     |     |     |     |     |     |     |     |      |      | Applying                         |      |      |
| CO3:                                                                                          | Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.           |     |     |     |     |     |     |     |     |      |      | Applying                         |      |      |
| CO4:                                                                                          | Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development. |     |     |     |     |     |     |     |     |      |      | Applying                         |      |      |
| CO5:                                                                                          | Analyze the various legal aspect and applications of reverse engineering in product design and development                                               |     |     |     |     |     |     |     |     |      |      | Analyzing                        |      |      |
| <b>Mapping of COs with POs and PSOs</b>                                                       |                                                                                                                                                          |     |     |     |     |     |     |     |     |      |      |                                  |      |      |
| COs/POs                                                                                       | PO1                                                                                                                                                      | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                             | PSO1 | PSO2 |
| CO1                                                                                           | 3                                                                                                                                                        | 2   | 1   | 1   | -   | -   | -   | -   | -   | -    | -    | -                                | -    | -    |
| CO2                                                                                           | 3                                                                                                                                                        | 3   | 1   | 2   | -   | -   | -   | -   | -   | -    | -    | -                                | -    | -    |
| CO3                                                                                           | 3                                                                                                                                                        | 3   | 1   | 2   | -   | 1   | -   | -   | -   | -    | -    | -                                | -    | -    |
| CO4                                                                                           | 3                                                                                                                                                        | 3   | 1   | 2   | -   | 1   | -   | -   | -   | -    | -    | -                                | -    | -    |
| CO5                                                                                           | 1                                                                                                                                                        | 2   | 1   | 1   | -   | 1   | -   | -   | -   | -    | -    | -                                | -    | -    |
| Avg.                                                                                          | 2.6                                                                                                                                                      |     | 1   | 1.6 | -   | 1   | -   | -   | -   | -    | -    | -                                | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial , BT – Bloom’s Taxonomy                             |                                                                                                                                                          |     |     |     |     |     |     |     |     |      |      |                                  |      |      |

|                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |   |        |          |   |   |   |        |     |   |   |   |   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|--------|----------|---|---|---|--------|-----|---|---|---|---|
| PPDT2413                                                                                                                                                                                                                                                                                                                                                                                 | CREATIVITY AND INNOVATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |        |          |   |   |   |        |     |   |   |   |   |
|                                                                                                                                                                                                                                                                                                                                                                                          | <table><tr><td>Category</td><td>L</td><td>T</td><td>P</td><td>Credit</td></tr><tr><td>PCC</td><td>3</td><td>0</td><td>0</td><td>3</td></tr></table>                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |        | Category | L | T | P | Credit | PCC | 3 | 0 | 0 | 3 |
| Category                                                                                                                                                                                                                                                                                                                                                                                 | L                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | T | P | Credit |          |   |   |   |        |     |   |   |   |   |
| PCC                                                                                                                                                                                                                                                                                                                                                                                      | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0 | 0 | 3      |          |   |   |   |        |     |   |   |   |   |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |   |        |          |   |   |   |        |     |   |   |   |   |
|                                                                                                                                                                                                                                                                                                                                                                                          | <ul style="list-style-type: none"><li>Applying the principles of essential theory of creativity in new product design and development.</li><li>Applying the principles of various methods and tools for creativity in new product design and development.</li><li>Applying the design principles of creativity in new product design and development.</li><li>Applying the various innovation principles and practices in new product design and development.</li><li>Applying the principles of innovation management in new product design and development.</li></ul> |   |   |        |          |   |   |   |        |     |   |   |   |   |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                                                 | INTRODUCTION TO ESSENTIAL THEORY OF CREATIVITY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |   |        | 9        |   |   |   |        |     |   |   |   |   |
| Directed creativity: The Need for Creative Thinking in the Pursuit of Quality - Essential Theory for Directed Creativity: Definitions and the Theory of the Mechanics of Mind; Heuristics and Models: Attitudes, Approaches, and Actions That Support Creative Thinking.                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |   |        |          |   |   |   |        |     |   |   |   |   |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                                                | METHODS AND TOOLS FOR CREATIVITY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |   |        | 9        |   |   |   |        |     |   |   |   |   |
| Three basic principles behind the tools of directed creativity – Tools that prepare the mind for creative thought – Tools that stimulate the imagination for new idea – Development and action: the bridge between mere creativity and the rewards of innovation - ICEDIP: Inspiration, Clarification, Distillation, Perspiration, Evaluation and Incubation – Creativity and Motivation |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |   |        |          |   |   |   |        |     |   |   |   |   |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                                               | DESIGN AND APPLICATION OF CREATIVITY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |   |        | 9        |   |   |   |        |     |   |   |   |   |
| Three levels of emotional design: Visceral, Behavioral and Reflective – Process design, reengineering, and creativity – Creativity and customer needs analysis – Innovative product and service design – Creative problem solving and incremental improvement.                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |   |        |          |   |   |   |        |     |   |   |   |   |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                                                | INNOVATION PRINCIPLES & PRACTICES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |   |        | 9        |   |   |   |        |     |   |   |   |   |
| Methods of Creativity Activation: Morphological Box – Requirements for Inventive Problem Solving – Altshuller’s Engineering Parameters– Altshuller’s Inventive Principles– Altshuller’s Contradiction Matrix Algorithm.                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |   |        |          |   |   |   |        |     |   |   |   |   |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                                                 | INNOVATION MANAGEMENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |   |        | 9        |   |   |   |        |     |   |   |   |   |
| Disruptive Innovation Model – Two Types of Disruption – Three Approaches to Creating New- Growth Businesses – New Market Disruptions: Three Case Histories – Product Architectures and Integration – Process of commoditization and de-commoditization – Two Processes of Strategy Formulation – Role of senior executive in leading new growth: The Disruptive Growth Engine.           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |   |        |          |   |   |   |        |     |   |   |   |   |
| Total: 45 periods                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |   |        |          |   |   |   |        |     |   |   |   |   |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |   |        |          |   |   |   |        |     |   |   |   |   |
| 1.                                                                                                                                                                                                                                                                                                                                                                                       | The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail by Clayton M. Christensen                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |   |        |          |   |   |   |        |     |   |   |   |   |
| 2.                                                                                                                                                                                                                                                                                                                                                                                       | Creative Confidence: Unleashing the Creative Potential Within Us All by Tom Kelley and David Kelley                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |        |          |   |   |   |        |     |   |   |   |   |
| REFERENCES:                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |   |        |          |   |   |   |        |     |   |   |   |   |
| 1.                                                                                                                                                                                                                                                                                                                                                                                       | . Clayton M. Christensen Michael E. Raynor,” The Innovator’s Solution”, Harvard Business School Press Boston, USA, 2013                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |   |        |          |   |   |   |        |     |   |   |   |   |
| 2.                                                                                                                                                                                                                                                                                                                                                                                       | Donald A. Norman,” Emotional Design”, Perseus Books Group New York , 2004                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |        |          |   |   |   |        |     |   |   |   |   |
| 3.                                                                                                                                                                                                                                                                                                                                                                                       | Geoffrey Petty,” how to be better at Creativity”, The Industrial Society 1999                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |   |        |          |   |   |   |        |     |   |   |   |   |
| 4.                                                                                                                                                                                                                                                                                                                                                                                       | Rousing Creativity: Think New Now Floyd Hurr, ISBN 1560525479, Crisp Publications Inc. 1999                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |   |        |          |   |   |   |        |     |   |   |   |   |

| COURSE OUTCOMES:<br>Upon completion of the course, the students will be able to |                                                                                                        |     |     |     |     |     |     |     |     |      | BT Mapped (Highest Level) |      |      |      |
|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|---------------------------|------|------|------|
| CO1:                                                                            | Apply the principles of essential theory of creativity in new product design and development.          |     |     |     |     |     |     |     |     |      | Applying                  |      |      |      |
| CO2:                                                                            | Apply the principles of various methods and tools for creativity in new product design and development |     |     |     |     |     |     |     |     |      | Applying                  |      |      |      |
| CO3:                                                                            | Apply the design principles of creativity in new product design and development.                       |     |     |     |     |     |     |     |     |      | Applying                  |      |      |      |
| CO4:                                                                            | Apply the various innovation principles and practices in new product design and development.           |     |     |     |     |     |     |     |     |      | Applying                  |      |      |      |
| CO5:                                                                            | Apply the principles of innovation management in new product design and development                    |     |     |     |     |     |     |     |     |      | Applying                  |      |      |      |
| Mapping of COs with POs and PSOs                                                |                                                                                                        |     |     |     |     |     |     |     |     |      |                           |      |      |      |
| COs/POs                                                                         | PO1                                                                                                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11                      | PO12 | PSO1 | PSO2 |
| CO1                                                                             | 2                                                                                                      | 2   | 2   | 3   | 2   | 3   | -   | -   | -   | -    | -                         | -    | -    | -    |
| CO2                                                                             | 2                                                                                                      | 2   | 2   | 3   | 2   | 3   | -   | -   | -   | -    | -                         | -    | -    | -    |
| CO3                                                                             | 2                                                                                                      | 2   | 2   | 3   | 2   | 3   | -   | -   | -   | -    | -                         | -    | -    | -    |
| CO4                                                                             | 2                                                                                                      | 2   | 2   | 3   | 2   | 3   | -   | -   | -   | -    | -                         | -    | -    | -    |
| CO5                                                                             | 2                                                                                                      | 2   | 2   | 3   | 2   | 3   | -   | -   | -   | -    | -                         | -    | -    | -    |
| Avg.                                                                            | 2                                                                                                      | 2   | 2   | 3   | 2   | 3   | -   | -   | -   | -    | -                         | -    | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial , BT – Bloom’s Taxonomy               |                                                                                                        |     |     |     |     |     |     |     |     |      |                           |      |      |      |

|                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |   |   |   |        |
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| PPDT2414                                                                                                                                                                                                                                                                                                               | INTEGRATED PRODUCT DEVELOPMENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | PCC      | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"><li>To Understand the principles of generic development process; product planning; customer need analysis for new product design and development.</li><li>To enhance the understanding of setting product specifications and generate, select, screen, and test concepts for new product design and development.</li><li>To apply the principles of product architecture and the importance of industrial design principles and DFM principles for new product development.</li><li>To expose the different Prototyping techniques, Design of Experiment principles to develop a robust design and importance to patent a developed new product.</li><li>Applying the concepts of economics principles; project management practices in development of new product.</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                               | INTRODUCTION TO PRODUCT DESIGN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |   |   |   | 9      |
| Characteristics of Successful Product development –Duration and Cost of Product Development – Challenges of Product Development - Product Development Processes and Organizations – Product Planning Process - Process of Identifying Customer Needs                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                              | PRODUCT SPECIFICATIONS, CONCEPT GENERATION, SELECTION AND TESTING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |   |   |   | 9      |
| Establish Target and Final product specifications – Activities of Concept Generation - Concept Screening and Scoring - Concept Testing Methodologies.                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                             | PRODUCT ARCHITECTURE AND INDUSTRIAL DESIGN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |          |   |   |   | 9      |
| Product Architecture – Implications and establishing the architecture – Delayed Differentiation – Platform Planning – Related system level design issues - Need and impact of industrial design - Industrial design process - management of the industrial design process - assessing the quality of industrial design |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                              | DESIGN FOR MANUFACTURE, PROTOTYPING AND ROBUST DESIGN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   | 9      |
| DFM Definition - Estimation of Manufacturing cost- Reducing the component costs, costs of supporting function and assembly costs – Impact of DFM decision on other factors - Prototype basics - Principles of prototyping – Prototyping technologies - Planning for prototypes - Robust design –Robust Design Process  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                               | PRODUCT DEVELOPMENT ECONOMICS AND MANAGING PROJECTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |   |   |   | 9      |
| Economic Analysis – Elements of Economic Analysis - Understanding and representing tasks- Baseline Project Planning - Accelerating the project - Project execution – Postmortem project evaluation.                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                     | Karl T.Ulrich, Steven D.Eppinger, Anita Goyal, "Product Design and Development", McGraw –Hill Education (India) Pvt. Ltd, 4th Edition, 2012.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                     | Kenneth Crow, "Concurrent Engineering/Integrated Product Development". DRM Associates, 6/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| 3.                                                                                                                                                                                                                                                                                                                     | Kevin N Otto, Kristin L Wood, “Product Design – Techniques in Reverse Engineering and New Product Development”, Pearson Education, Inc, 2016                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
| 4.                                                                                                                                                                                                                                                                                                                     | Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin Homewood, 1992                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   |        |

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| 5. | Stuart Pugh, "Total Design – Integrated Methods for successful Product Engineering", Addison Wesley Publishing, New York, NY, 1991. |
|----|-------------------------------------------------------------------------------------------------------------------------------------|

| <b>COURSE OUTCOMES:</b><br><b>Upon completion of this course, the students will be able to:</b> |                                                                                                                                                                        | <b>BT Mapped<br/>(Highest Level)</b> |
|-------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|
| CO1:                                                                                            | Apply the principles of generic development process; product planning; customer need analysis for new product design and development.                                  | Applying                             |
| CO2:                                                                                            | Set product specifications and generate, select, screen, test concepts for new product design and development                                                          | Analysing                            |
| CO3:                                                                                            | Apply the principles of product architecture, industrial design and design for manufacturing principles in new product development.                                    | Applying                             |
| CO4:                                                                                            | Apply the adopt Prototyping techniques and Design of Experiment principles to develop a robust design and document a new product for patent.                           | Applying                             |
| CO5:                                                                                            | Apply the fundamental elements of economic analysis and project planning to understand, represent, accelerate, execute, and evaluate engineering projects effectively. | Applying                             |
|                                                                                                 |                                                                                                                                                                        |                                      |

#### Mapping of COs with POs and PSOs

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1     | 3   | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2     | 3   | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO3     | 3   | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO4     | 3   | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO5     | 3   | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| Avg.    | 3   | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -    | -    | -    | -    | -    |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

|                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|---|--------|
| PRMT2411                                                                                                                                                                                                                                                                                                                                                    | RESEARCH METHODOLOGY AND IPR                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                     | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                     | PCC      | 2 | 0 | 0 | 2      |
| Course objectives                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                             | <ul style="list-style-type: none"><li>• Understanding the Foundations of Research Methodology</li><li>• Application of Ethical Research Practices</li><li>• Exploring Intellectual Property Rights (IPR)</li><li>• Linking Research and Innovation with IPR Protection</li><li>• Critical Evaluation of IPR Policies and Global Standards</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                    | RESEARCH DESIGN                                                                                                                                                                                                                                                                                                                                     |          |   |   |   | 9      |
| Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                   | DATA COLLECTION AND SOURCES                                                                                                                                                                                                                                                                                                                         |          |   |   |   | 9      |
| Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                  | DATA ANALYSIS AND REPORTING                                                                                                                                                                                                                                                                                                                         |          |   |   |   | 9      |
| Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                   | INTELLECTUAL PROPERTY RIGHTS                                                                                                                                                                                                                                                                                                                        |          |   |   |   | 9      |
| Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance. |                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                    | PATENTS                                                                                                                                                                                                                                                                                                                                             |          |   |   |   | 9      |
| Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.                                   |                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                          | "Research Methodology: A Step-by-Step Guide for Beginners" by Ranjit Kumar                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                          | "Intellectual Property: A Very Short Introduction" by Siva Vaidhyanathan                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                          | Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012)                                                                                                                                                                                                                              |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                          | Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007                                                                                                                                                                                                                             |          |   |   |   |        |
| 3.                                                                                                                                                                                                                                                                                                                                                          | David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.                                                                                                                                                                                                                                                      |          |   |   |   |        |
| 4.                                                                                                                                                                                                                                                                                                                                                          | The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.                                                                                                                                                                  |          |   |   |   |        |

| COURSE OUTCOMES:                                                  |                                                     |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------|-----------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                              | Understanding and Applying Research Methodologies   |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO2:                                                              | Ethical Research Practices and Integrity            |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO3:                                                              | Deep Knowledge of Intellectual Property Rights      |     |     |     |     |     |     |     |     |      |      | Remembering                  |      |      |
| CO4:                                                              | Linking Research Outcomes with IPR Protection       |     |     |     |     |     |     |     |     |      |      | Analyzing                    |      |      |
| CO5:                                                              | Critical Thinking on IPR Policies and Global Issues |     |     |     |     |     |     |     |     |      |      | Evaluating                   |      |      |
| Mapping of COs with POs and PSOs                                  |                                                     |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/POs                                                           | PO1                                                 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                               | 3                                                   | 2   | -   | 3   | -   | -   | -   | -   | -   | -    | -    | 2                            | -    | -    |
| CO2                                                               | -                                                   | -   | -   | -   | -   | -   | -   | 3   | 2   | -    | -    | 2                            | -    | -    |
| CO3                                                               | -                                                   | -   | -   | -   | -   | 3   | -   | -   | -   | -    | -    | 3                            | -    | -    |
| CO4                                                               | -                                                   | -   | 3   | -   | 2   | 2   | -   | -   | -   | -    | -    | 2                            | -    | -    |
| CO5                                                               | -                                                   | -   | -   | -   | -   | 3   | 2   | -   | -   | -    | -    | 3                            | -    | -    |
| Avg.                                                              | 3                                                   | 2   | 3   | 3   | 2   | 2.6 | 2   | 3   | 2   | -    | -    | 2.4                          | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial , BT – Bloom’s Taxonomy |                                                     |     |     |     |     |     |     |     |     |      |      |                              |      |      |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                  |          |   |   |   |        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|---|--------|
| PPDL2411                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Cad Laboratory and Multi body Dynamics Lab                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                  | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                  | ESC      | 0 | 0 | 4 | 2      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                  |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <ul style="list-style-type: none"><li>• To impart knowledge on how to prepare drawings for various mechanical components using any commercially available 3D modelling software's.</li><li>• To expose the students to understand the forces and torques that come into action in various kinds of mechanical systems.</li></ul> |          |   |   |   |        |
| <ol style="list-style-type: none"><li>1. CAD Introduction &amp; Sketcher</li><li>2. Solid modeling–Extrude, Revolve, Sweep, etc and Variational sweep, Loft, etc</li><li>3. Surface modeling–Extrude, Sweep, Trim..etc and Mesh of curves, Free form etc</li><li>4. Feature manipulation – Copy, Edit, Pattern, Suppress, History operations etc.</li><li>5. Assembly-Constraints, Exploded Views, Interference check</li><li>6. Drafting - Layouts, Standard &amp; Sectional Views, Detailing &amp;Plotting.</li><li>7. CAD data Exchange formats-IGES,PDES, PARASOLID,DXF and STL.</li><li>8. Free fall of rigid body</li><li>9. Projectile motion</li><li>10. Simulation of simple &amp; Compound Pendulum</li><li>11. Kinematic &amp; Dynamic Analysis four bar and slider crank mechanism and its inversions</li><li>12. Design of cam Profile for various follower output motion</li><li>13. Kinematic &amp; Dynamic Analysis of Gear Tracks</li><li>14. Vibration Analysis SDOF and MDOF</li><li>15. Project on virtual product design using ADAMS</li></ol> |                                                                                                                                                                                                                                                                                                                                  |          |   |   |   |        |
| <ul style="list-style-type: none"><li>• Exercises in Modeling and drafting of Mechanical Components - Assembly using Parametric and feature based Packages like PRO-E / SOLID WORKS /CATIA / NX etc.</li><li>• Exercises in kinematics and dynamics using equations of motion in package like ADAMS.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                  |          |   |   |   |        |
| Total: 60 periods                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                  |          |   |   |   |        |

| <b>COURSE OUTCOMES:</b>                                   |                                                                                                                                                                      | <b>BT Mapped (Highest Level)</b> |
|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| On completion of the course, the students will be able to |                                                                                                                                                                      |                                  |
| CO1:                                                      | With laboratory classes, it helps the students to get familiarized with the computer applications in design and preparing drawings for various mechanical components | Applying                         |
| CO2:                                                      | The students get familiarized with modeling different systems and importing them into the multi body dynamic software.                                               | Applying                         |
| CO3:                                                      | The students will be trained to obtain required dynamic properties by conducting multi body dynamic tests                                                            | Analyzing                        |
| CO4:                                                      | The students will learn how to use this data in additional stress analysis software.                                                                                 | Applying                         |

| <b>Mapping of COs with POs and PSOs</b>                          |     |     |     |     |     |     |
|------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|
| COs/POs                                                          | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1                                                              | 3   | 3   | 3   | 2   | -   | -   |
| CO2                                                              | 3   | 3   | 3   | 2   | -   | -   |
| CO3                                                              | 3   | 3   | 3   | 2   | -   | -   |
| CO4                                                              | 3   | 3   | 3   | 2   | -   | -   |
| avg                                                              | 3   | 3   | 3   | 2   | -   | -   |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom’s Taxonomy |     |     |     |     |     |     |

| PPDL2412                                                                                                                                                                                                                                                                                                                                                                                                                  |  | Reverse Engineering Laboratory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |   |   |        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|--------|
|                                                                                                                                                                                                                                                                                                                                                                                                                           |  | Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                                           |  | ESC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0 | 0 | 4 | 2      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                                         |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                           |  | <ul style="list-style-type: none"> <li>Applying the fundamental concepts and principles of reverse engineering in product design and development.</li> <li>. Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.</li> <li>Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.</li> <li>Applying the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.</li> <li>Analyzing the various legal aspect and applications of reverse engineering in product design and development.</li> </ul> |   |   |   |        |
| <ul style="list-style-type: none"> <li><b>Exercises</b> <ol style="list-style-type: none"> <li>Surface measurement – CMM.</li> <li>3D Laser scanning of components.</li> <li>Reverse engineering of Automotive components-cam shaft.</li> <li>Material identification and process verification of welded components.</li> <li>Reverse engineering of dental components - Bio medical applications.</li> </ol> </li> </ul> |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                           |  | <b>Total: 60 periods</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |

| <b>COURSE OUTCOMES:</b>                                   |                                                                                                                                                         | <b>BT Mapped (Highest Level)</b> |
|-----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| On completion of the course, the students will be able to |                                                                                                                                                         |                                  |
| CO1:                                                      | Apply the fundamental concepts and principles of reverse engineering in product design and development                                                  | Applying                         |
| CO2:                                                      | Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development | Applying                         |
| CO3:                                                      | Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.          | Applying                         |
| CO4:                                                      | Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development | Applying                         |
| CO5:                                                      | Analyze the various legal aspect and applications of reverse engineering in product design and development.                                             | Analyzing                        |

| Mapping of COs with POs and PSOs                                 |     |     |     |     |     |     |
|------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|
| COs/POs                                                          | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1                                                              | 3   | 2   | 1   | 1   | -   | -   |
| CO2                                                              | 3   | 3   | 1   | 2   | -   | -   |
| CO3                                                              | 3   | 3   | 1   | 2   | -   | 1   |
| CO4                                                              | 3   | 3   | 1   | 2   | -   | 1   |
| CO5                                                              | 1   | 2   | 1   | 1   |     | 1   |
| avg                                                              | 2.6 | 2.6 | 1   | 1.6 | -   | 1   |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom’s Taxonomy |     |     |     |     |     |     |

|                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|---|--------|
| PPDT2421                                                                                                                                                                                                                                                                                                                                                                                                            | FINITE ELEMENT METHODS IN MECHANICAL DESIGN                                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | PCC      | 3 | 1 | 0 | 4      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                     | <ul style="list-style-type: none"><li>To learn mathematical models for one dimensional problems and their numerical solutions</li><li>To learn two dimensional scalar and vector variable problems to determine field variables</li><li>To learn Iso parametric transformation and numerical integration for evaluation of element matrices</li><li>To study various solution techniques to solve Eigen value problems</li><li>To learn solution techniques to solve non-linear problems</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                                                                            | FINITE ELEMENT ANALYSIS OF ONEDIMENSIONAL PROBLEMS                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |   |   |   | 9      |
| Historical Background – Weighted Residual Methods - Basic Concept of FEM – Variational Formulation of B.V.P. – Ritz Method – Finite Element Modelling – Element Equations – Linear and Higher order Shape functions – Bar, Beam Elements –Applications to Heat Transfer problems.                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                                                                           | FINITE ELEMENT ANALYSIS OF TWO DIMENSIONAL PROBLEMS                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   | 9      |
| Basic Boundary Value Problems in two-dimensions – Linear and higher order Triangular, quadrilateral elements – Poisson’s and Laplace’s Equation – Weak Formulation – Element Matrices and Vectors – Application to scalar variable problems - Introduction to Theory of Elasticity – Plane Stress – Plane Strain and Axisymmetric Formulation – Principle of virtual work – Element matrices using energy approach. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                                                                          | ISO-PARAMETRIC FORMULATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   | 9      |
| Natural Co-ordinate Systems – Lagrangian Interpolation Polynomials – Iso parametric Elements – Formulation – Shape functions -one dimensional , two dimensional triangular and quadrilateral elements - Serendipity elements- Jacobian transformation - Numerical Integration – Gauss quadrature – one, two and three point integration                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                                                                           | EIGEN VALUE PROBLEMS                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |   |   |   | 9      |
| Dynamic Analysis – Equations of Motion – Consistent and lumped mass matrices – Free Vibration analysis – Natural frequencies of Longitudinal, Transverse and torsional vibration – Solution of Eigenvalue problems - Introduction to transient field problems                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                                                                            | NON-LINEAR ANALYSIS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   | 9      |
| Introduction to Non-linear problems - some solution techniques- computational procedurematerial non-linearity-Plasticity and viscoplasticity, stress stiffening, contact interfaces- problems of gaps and contact - geometric non-linearity - modeling considerations - Free and Mapped meshing -Mesh quality- Error estimate                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                  | "Introduction to Finite Element Analysis and Design" by Nam-Ho Kim, Bhavani V. Sankar, and Young W. Kwon                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                  | "Finite Element Method: Linear Static and Dynamic Finite Element Analysis" by Thomas J.R. Hughes                                                                                                                                                                                                                                                                                                                                                                                                   |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                  | Bathe K.J., “Finite Element Procedures in Engineering Analysis”, Prentice Hall, 1990                                                                                                                                                                                                                                                                                                                                                                                                               |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                  | David Hutton, “Fundamentals of Finite Element Analysis”, Tata McGraw Hill, 2005                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                  | Rao, S.S., “The Finite Element Method in Engineering”, 6 th Edition, ButterworthHeinemann,2018                                                                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                  | Reddy, J.N. “Introduction to the Finite Element Method”, 4 th Edition, Tata McGraw Hill,2018                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |

|    |                                                                                                                                                             |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5. | Seshu.P, “Text Book of Finite Element Analysis”, PHI Learning Pvt. Ltd., New Delhi, 2012                                                                    |
| 6. | Tirupathi R. Chandrupatla and Ashok D. Belegundu, “Introduction to Finite Elements in Engineering”, International Edition, Pearson Education Limited, 2014. |

| <b>COURSE OUTCOMES:<br/>On Completion of the course the student will be able to</b> |                                                                                                 | <b>BT Mapped<br/>(Highest Level)</b> |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|--------------------------------------|
| CO1:                                                                                | Develop mathematical models for one dimensional problems and their numerical solutions          | Creating                             |
| CO2:                                                                                | Determine field variables for two dimensional scalar and vector variable problems               | Analysing                            |
| CO3:                                                                                | Apply Isoparametric transformation and numerical integration for evaluation of element matrices | Applying                             |
| CO4:                                                                                | Apply various solution techniques to solve Eigen value problems                                 | Applying                             |
| CO5:                                                                                | Formulate solution techniques to solve non-linear problems                                      | Creating                             |

#### Mapping of COs with POs and PSOs

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1     | 3   | 2   | 2   | 2   | 3   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2     | 3   | 2   | 2   | 2   | 3   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO3     | 3   | 2   | 2   | 2   | 3   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO4     | 3   | 2   | 2   | 2   | 3   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO5     | 3   | 2   | 2   | 2   | 3   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| Avg.    | 3   | 2   | 2   | 2   | 3   | -   | -   | -   | -   | -    | -    | -    | -    | -    |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom’s Taxonomy

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| PPDT2422 | DESIGNING WITH ADVANCED MATERIALS |  |  |  |  |
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| COURSE OUTCOMES:<br>On Completion of the course the student will be able to |                                                                                                    |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-----------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                        | Analyze the different strengthening and failure mechanism of the metals                            |     |     |     |     |     |     |     |     |      |      | Analyzing                    |      |      |
| CO2:                                                                        | Apply the effects of metallurgical parameters in the materials design                              |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO3:                                                                        | Analyze the relationship between the selection of materials and processing                         |     |     |     |     |     |     |     |     |      |      | Analyzing                    |      |      |
| CO4:                                                                        | Develop the novel material through understanding the properties of the existing metallic materials |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| CO5:                                                                        | Analyze the different materials used in the engineering applications                               |     |     |     |     |     |     |     |     |      |      | Analyzing                    |      |      |
| Mapping of COs with POs and PSOs                                            |                                                                                                    |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/POs                                                                     | PO1                                                                                                | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                         | 3                                                                                                  | -   | 3   | 1   | 1   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                         | 3                                                                                                  | -   | 3   | 1   | 1   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                         | 3.                                                                                                 | -   | 3   | 1   | 1   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                         | 3                                                                                                  | -   | 3   | 1   | 1   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                         | 3                                                                                                  | -   | 3   | 1   | 1   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                        | 3                                                                                                  | -   | 3   | 1   | 1   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial , BT – Bloom’s Taxonomy           |                                                                                                    |     |     |     |     |     |     |     |     |      |      |                              |      |      |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   |        |
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| PPDT2423                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | SOLID FREEFORM MANUFACTURING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | PCC      | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <ul style="list-style-type: none"><li>• To acquaint the students with evolution of Solid Freeform Manufacturing (SFM) / Additive Manufacturing (AM), proliferation into various fields and its effects on supply chain.</li><li>• To gain knowledge on Design for Additive Manufacturing (DFAM) and its importance in quality improvement of fabricated parts.</li><li>• To acquaint with polymerization and sheet lamination processes and their applications.</li><li>• To acquaint with material extrusion and powder bed fusion processes.</li><li>• To gain knowledge on jetting and direct energy deposition processes and their applications.</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | INTRODUCTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |   |   |   | 9      |
| Need - Development of SFM systems – Hierarchical structure of SFM - SFM process chain – Classification – Applications. Case studies: Bio printing- Food Printing- Electronics printing – Rapid Tooling - Building printing. AM Supply chain. Economics aspect: Strategic aspect- Operative aspect.                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | DESIGN FOR ADDITIVE MANUFACTURING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |   |   |   | 9      |
| Concepts and Objectives - AM Unique Capabilities - Part Consolidation - Topology Optimization - Lightweight Structures - DFAM for Part Quality Improvement - CAD Modeling - Model Reconstruction - Data Processing for AM - Data Formats - Data Interfacing - Part Orientation - Support Structure Design and Support Structure Generation - Model Slicing - Tool Path Generation. Design Requirements of Additive Manufacturing: For Part Production, For Mass Production, For Series Production. Case Studies                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | VAT POLYMERIZATION AND SHEET LAMINATION PROCESSES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |   |   |   | 9      |
| Stereolithography Apparatus (SLA): Principles – Photo Polymerization of SL Resins - Pre Build Process – Part-Building and Post-Build Processes - Part Quality and Process Planning, Recoating Issues - Materials - Advantages - Limitations and Applications. Digital Light Processing (DLP) - Materials - Process - Advantages and Applications. Laminated Object Manufacturing (LOM): Working Principles - Process - Materials, Advantages, Limitations and Applications. Ultrasonic Additive Manufacturing (UAM) - Process - Parameters - Applications. Case Studies. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | MATERIAL EXTRUSION AND POWDER BED FUSION PROCESSES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |   |   |   | 9      |
| Fused deposition Modeling (FDM): Working Principles - Process - Materials and Applications. Design Rules for FDM. Selective Laser Sintering (SLS): Principles - Process - Indirect and Direct SLS - Powder Structure – Materials - Surface Deviation and Accuracy - Applications. Multijet Fusion. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Principles – Processes – Materials – Advantages - Limitations and Applications. Case Studies.                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | JETTING AND DIRECT ENERGY DEPOSITION PROCESSES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |   |   |   | 9      |
| Binder Jetting: Three dimensional Printing (3DP): Principles – Process - Physics of 3DP - Types of printing: Continuous mode – Drop on Demand mode - Process – Materials - Advantages - Limitations - Applications. Material Jetting: Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations. Laser Engineered Net Shaping (LENS): Processes- Materials- Advantages - Limitations and Applications. Case Studies                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | "Solid Freeform Fabrication: A New Direction in Manufacturing" by Gregory S. Roth                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | "Additive Manufacturing: Materials, Processes, Quantifications and Applications" by Kun Zhou, Yipeng Liu, and Zhiyong Yu                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Andreas Gebhardt and Jan-Steffen Hotter, “Additive Manufacturing:3D Printing for Prototyping and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |   |   |   |        |

|    |                                                                                                                                                                                                             |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | Manufacturing”, Hanser publications Munchen, Germany, 2016. ISBN:978-1-56990-582-1.                                                                                                                         |
| 2. | Ben Redwood, Brian Garret, FilemonSchöffner, and Tony Fadel, “The 3D Printing Handbook: Technologies, Design and Applications”, 3D Hubs B.V., Netherland, 2017. ISBN-13: 978- 9082748505                    |
| 3. | Ian Gibson, David W. Rosen and Brent Stucker, “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing” Springer - New York, USA, 2nd Edition, 2015. ISBN13: 978-1493921126. |
| 4. | Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press, 1st Edition, 2007 FL, USA. ISBN- 9780849334092.                               |
| 5. | Milan Brandt., “Laser Additive Manufacturing 1st Edition Materials, Design, Technologies, and Applications”, Woodhead Publishing, UK, 2016. ISBN- 9780081004333.                                            |

| <b>COURSE OUTCOMES:</b><br><b>At the end of this course, the students shall be able to:</b> |                                                                                                                          | <b>BT Mapped (Highest Level)</b> |
|---------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| CO1:                                                                                        | Relate the importance in the evolution of SFM/AM, proliferation into the various fields and its effects on supply chain. | Analyzing                        |
| CO2:                                                                                        | Analyze the design for AM and its importance in the quality of fabricated parts.                                         | Analyzing                        |
| CO3:                                                                                        | Build knowledge on principles and applications of polymerization and sheet lamination processes with case studies.       | Applying                         |
| CO4:                                                                                        | Explain the principles of material extrusion and powder bed fusion processes and design guidelines.                      | Understanding                    |
| CO5:                                                                                        | Elaborate jetting and direct energy deposition processes and their applications.                                         | Applying                         |

**Mapping of COs with POs and PSOs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1<br>0 | PO1<br>1 | PO1<br>2 | PSO<br>1 | PSO<br>2 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------|----------|----------|----------|----------|
| CO1     | 2   | 3   | 1   | 3   | 3   | 2   | -   |     | -   |          | -        |          | -        |          |
| CO2     | 3   | 2   | 3   | 3   | 3   | 2   | -   |     | -   |          | -        |          | -        |          |
| CO3     | 3   | 3   | 2   | 3   | 2   | 1   | -   |     | -   |          | -        |          | -        |          |
| CO4     | 3   | 3   | 2   | 3   | 2   | 1   | -   |     | -   |          | -        |          | -        |          |
| CO5     | 3   | 3   | 2   | 3   | 2   | 1   | -   |     | -   |          | -        |          | -        |          |
| Avg.    | 2.8 | 2.8 | 2   | 3   | 2.5 | 1.4 | -   |     | -   |          | -        |          | -        |          |

1 – Slight, 2 – Moderate, 3 – Substantial , BT – Bloom’s Taxonomy

|                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|---|--------|
| PPDT2424                                                                                                                                                                                                                                                                                                                                  | DESIGN FOR MANUFACTURE AND ASSEMBLY                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                           | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                           | PCC      | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                           | <ul style="list-style-type: none"><li>To apply various design rules in manufacturing processes</li><li>To evaluate the process by design guidelines for optimum design</li><li>To analyze the rules of concepts of GD&amp; T</li><li>To make the students to learn about tolerance analysis and allocation, geometrical tolerances Guidelines for design for manufacturing and assembly with suitable examples.</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                  | TOLERANCE ANALYSIS                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   | 9      |
| Introduction – Concepts, definitions and relationships of tolerancing – Matching design tolerances with appropriate manufacturing process – manufacturing process capability metrics – Worst care, statistical tolerance Analysis – Linear and Non-Linear Analysis – Sensitivity Analysis – Taguchi’s Approach to tolerance design.       |                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                 | TOLERANCE ALLOCATION                                                                                                                                                                                                                                                                                                                                                                                                      |          |   |   |   | 9      |
| Tolerance synthesis – Computer Aided tolerancing – Traditional cost based analysis – Taguchi’s quality loss function – Application of the Quadratic loss function to Tolerancing – Principles of selective Assembly – Problems.                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                | GD&T                                                                                                                                                                                                                                                                                                                                                                                                                      |          |   |   |   | 9      |
| Fundamentals of geometric dimensioning and tolerancing – Rules and concepts of GD&T – Form controls – Datum systems – Orientation controls – Tolerance of position – Concentricity and symmetry controls – Run out controls – Profile controls.                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                 | TOLERANCE CHARTING                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   | 9      |
| Nature of the tolerance buildup – structure and setup of the tolerance chart – piece part sketches for tolerance charts – Arithmetic ground rules for tolerance charts – Determination of Required balance dimensions – Determination of Mean working Dimensions – Automatic tolerance charting – Tolerance charting of Angular surfaces. |                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                  | MANUFACTURING GUIDELINES                                                                                                                                                                                                                                                                                                                                                                                                  |          |   |   |   | 9      |
| DFM guidelines for casting, weldment design – Formed metal components – Turned parts – Milled, Drilled parts – Non-metallic parts – Computer Aided DFM software – Boothroyd and Dewhurst method of DFMA – DCS – Vis/VSA – 3D Dimensional control – Statistical tolerance Analysis Software – Applications.                                |                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                        | "Design for Manufacturability and Assembly" by Geoffrey Boothroyd and Peter Dewhurst                                                                                                                                                                                                                                                                                                                                      |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                        | "Product Design for Manufacture and Assembly" by Geoffrey Boothroyd, Peter Dewhurst, and Winston Knight                                                                                                                                                                                                                                                                                                                   |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                        | Alex Krulikowski, “Fundamentals GD&T”, Delmar Thomson Learning, 1997                                                                                                                                                                                                                                                                                                                                                      |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                        | . C.M. Creveling, “Tolerance Design – A handbook for Developing Optimal Specifications”, Addison – Wesley, 1997.                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| 3.                                                                                                                                                                                                                                                                                                                                        | James D. Meadows, ‘Geometric Dimensioning and Tolerancing’, Marcel Dekker Inc., 1995.                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
| 4.                                                                                                                                                                                                                                                                                                                                        | James G. Bralla, “Handbook of Product Design for Manufacturing”, McGraw Hill, 1986.                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| 5.                                                                                                                                                                                                                                                                                                                                        | Oliver R. Wade, “Tolerance Control in Design and Manufacturing”, Industrial Press, NY, 1967.                                                                                                                                                                                                                                                                                                                              |          |   |   |   |        |

| COURSE OUTCOMES:<br>At the end of this course the students are expected |                                                                                         |     |     |      |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-----|-----|------|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                    | To impart the knowledge about the significance of design for manufacturing and assembly |     |     |      |     |     |     |     |     |      |      | Understanding                |      |      |
| CO2:                                                                    | To apply the principle of tolerancing in design                                         |     |     |      |     |     |     |     |     |      |      | Applying                     |      |      |
| CO3:                                                                    | Evaluate the process of GD & T using design guidelines                                  |     |     |      |     |     |     |     |     |      |      | Evaluating                   |      |      |
| CO4:                                                                    | Apply tolerance allocation and tolerance charting in design                             |     |     |      |     |     |     |     |     |      |      | Applying                     |      |      |
| CO5:                                                                    | Apply guidelines for manufacturing and assembly                                         |     |     |      |     |     |     |     |     |      |      | Applying                     |      |      |
| Mapping of COs with POs and PSOs                                        |                                                                                         |     |     |      |     |     |     |     |     |      |      |                              |      |      |
| COs/POs                                                                 | PO1                                                                                     | PO2 | PO3 | PO4  | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                     | 1                                                                                       | -   | -   | 3    | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                     | 1                                                                                       | 1   | -   | 2    | 1   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                     | -                                                                                       | -   | 3   | 2    | 1   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                     | 1                                                                                       | -   | -   | -    | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                     | -                                                                                       | -   | -   | 2    | 1   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                    | 1                                                                                       | 1   | 3   | 2.25 | 1   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial , BT – Bloom’s Taxonomy       |                                                                                         |     |     |      |     |     |     |     |     |      |      |                              |      |      |

|                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|---|--------|
| PPDT2425                                                                                                                                                                                                                                                                                                                                                                                                                      | CONCEPTS OF ENGINEERING DESIGN                                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | PCC      | 0 | 0 | 4 | 2      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                               | <ul style="list-style-type: none"><li>• To impart knowledge on basic concepts in engineering design.</li><li>• To develop a product catering to the need sofa customer and considering quality and societal aspects in design</li><li>• To incorporate various design methods to develop a creative product.</li><li>• To gain knowledge on the selection of materials and manufacturing techniques for product design.</li><li>• To develop a robust and reliable product.</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                                                                                      | DESIGN FUNDAMENTALS                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |   |   |   | 9      |
| Importance of design- The design process-Considerations of Good Design – Morphology of design–Organization for design–Computer-Aided Engineering–Designing to codes and standards–Concurrent Engineering–Product and process cycles–Technological Forecasting – Market Identification –Competition Benchmarking                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                                                                                     | CUSTOMER-ORIENTED DESIGN&SOCIETAL CONSIDERATIONS                                                                                                                                                                                                                                                                                                                                                                                                                                      |          |   |   |   | 9      |
| Identification of customer needs- customer requirements- Quality Function Deployment- Product Design Specifications-Human Factors in Design–Ergonomics, and Aesthetics, Societal consideration - Contracts – Product liability – Protecting intellectual property – Legal and ethical domains – Codes of ethics - Ethical conflicts – Environment responsible design-future trends in interaction of engineering with society |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                                                                                    | DESIGN METHODS                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   | 9      |
| Creativity and problem solving–Creativity methods-Theory of Inventive Problem Solving(TRIZ)– Conceptual decomposition-Generating design concepts-Axiomatic Design–Evaluation methods Embodiment Design-Product Architecture-Configuration Design- Parametric Design. Role of models in design-Mathematical Modeling – Simulation – Geometric Modeling –Rapid prototyping-Finite Element Analysis– Optimization–Search Methods |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                                                                                     | MATERIAL SELECTION PROCESSING AND DESIGN                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |   |   |   | 9      |
| Material Selection Process–Economics–Cost Vs Performance–Weighted property Index–Value Analysis– Role of Processing in Design–Classification of Manufacturing Process–Design for Manufacture – Design for Assembly –Designing for castings, Forging, Metal Forming, Machining and Welding– Residual Stresses– Fatigue, Fracture, and Failure.                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                                                                                      | PROBABILITY CONCEPTS IN DESIGN FOR RELIABILITY                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   | 9      |
| Probability–Distributions–Test of Hypothesis–Design of Experiments–Reliability Theory–Design for Reliability–Reliability centered Maintenance-Robust Design-Failure mode Effect Analysis                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                            | "Engineering Design: A Materials and Processing Approach" by George E. Dieter                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                            | "Product Design and Development" by Karl T. Ulrich and Steven D. Eppinger                                                                                                                                                                                                                                                                                                                                                                                                             |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                            | George E. Dieter, Linda C. Schmidt, “Engineering Design”, McGraw Hill Education Pvt.Ltd.,2013                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                            | Pahl.G,Beitz.W,“Engineering Design- A systematic approach”, Springer–Verlag,2005                                                                                                                                                                                                                                                                                                                                                                                                      |          |   |   |   |        |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                            | Ray,M.S.,“Elements of Engineering Design”, Prentice HallInc.1985                                                                                                                                                                                                                                                                                                                                                                                                                      |          |   |   |   |        |

|                                                                                            |                                                                                                             |     |     |     |     |     |     |     |     |      |      |                                      |      |      |
|--------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|--------------------------------------|------|------|
| 4.                                                                                         | Nam P. Suh, Ralph & Eloise F. Cross, “The Principles of Design”, Oxford University Press,1990               |     |     |     |     |     |     |     |     |      |      |                                      |      |      |
| 5.                                                                                         | Karl T. Ulrich, Steven D. Eppinger, “Product Design And Development, Tata Mcgraw-Hill Education,2015        |     |     |     |     |     |     |     |     |      |      |                                      |      |      |
| <b>COURSE OUTCOMES:</b><br><b>On Completion of the course, the student will be able to</b> |                                                                                                             |     |     |     |     |     |     |     |     |      |      | <b>BT Mapped<br/>(Highest Level)</b> |      |      |
| CO1:                                                                                       | Appreciate the aspects of the need for design, design process used for designing various components.        |     |     |     |     |     |     |     |     |      |      | Understanding                        |      |      |
| CO2:                                                                                       | Get familiarized with concepts related to legal, human, and marketing factors during the design of products |     |     |     |     |     |     |     |     |      |      | Understanding                        |      |      |
| CO3:                                                                                       | Get acquainted with the knowledge of designing creative components.                                         |     |     |     |     |     |     |     |     |      |      | Applying                             |      |      |
| CO4:                                                                                       | Gain knowledge on the material selection process and various design procedures                              |     |     |     |     |     |     |     |     |      |      | Applying                             |      |      |
| CO5:                                                                                       | Get equipped with tools for improving quality, reliability, and performance of a product.                   |     |     |     |     |     |     |     |     |      |      | Analyzing                            |      |      |
| <b>Mapping of COs with POs and PSOs</b>                                                    |                                                                                                             |     |     |     |     |     |     |     |     |      |      |                                      |      |      |
| COs/POs                                                                                    | PO1                                                                                                         | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                                 | PSO1 | PSO2 |
| CO1                                                                                        | 3                                                                                                           | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -                                    | -    | -    |
| CO2                                                                                        | 3                                                                                                           | 2   | 2   | -   | -   | 1   | -   | -   | -   | -    | -    | -                                    | -    | -    |
| CO3                                                                                        | 3                                                                                                           | 2   | 2   | -   | 1   | -   | -   | -   | -   | -    | -    | -                                    | -    | -    |
| CO4                                                                                        | 3                                                                                                           | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -                                    | -    | -    |
| CO5                                                                                        | 3                                                                                                           | 2   | 2   | 2   | 1   | -   | -   | -   | -   | -    | -    | -                                    | -    | -    |
| Avg.                                                                                       | 3                                                                                                           | 2   | 2   | 2   | 1   | 1   | -   | -   | -   | -    | -    | -                                    | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial , BT – Bloom’s Taxonomy                          |                                                                                                             |     |     |     |     |     |     |     |     |      |      |                                      |      |      |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                       |          |   |   |   |                   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|---|-------------------|
| PPDL2421                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Advanced Analysis and Simulation Laboratory                                                                                                                                                                           |          |   |   |   |                   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                       | Category | L | T | P | Credit            |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                       | ESC      | 0 | 0 | 4 | 2                 |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                       |          |   |   |   |                   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <ul style="list-style-type: none"><li>To give exposure to software tools needed to analyze engineering problems.</li><li>To expose the students to different applications of simulation and analysis tools.</li></ul> |          |   |   |   |                   |
| A. SIMULATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                       |          |   |   |   |                   |
| <ul style="list-style-type: none"><li>MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables</li><li>Use of MATLAB to solve simple problems in vibration</li><li>Mechanism Simulation using Multibody Dynamic software.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                       |          |   |   |   |                   |
| B. ANALYSIS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                       |          |   |   |   |                   |
| <ul style="list-style-type: none"><li>Force and Stress analysis using link elements in Trusses, cables etc.</li><li>Stress and deflection analysis in beams with different support conditions.</li><li>Stress analysis of flat plates and simple shells.</li><li>Stress analysis of axi – symmetric components.</li><li>Thermal stress and heat transfer analysis of plates.</li><li>Thermal stress analysis of cylindrical shells</li><li>Vibration analysis of spring-mass systems.</li><li>Model analysis of Beams.</li><li>Harmonic, transient and spectrum analysis of simple systems.</li><li>Analysis of machine elements under dynamic loads</li><li>Analysis of non-linear systems</li></ul> |                                                                                                                                                                                                                       |          |   |   |   |                   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                       |          |   |   |   | Total: 60 periods |
| List of Equipment / Software:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                       |          |   |   |   |                   |
| Finite Element Analysis packages                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                       |          |   |   |   |                   |

|                                                           |                                                                                               |                                  |
|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------|----------------------------------|
| <b>COURSE OUTCOMES:</b>                                   |                                                                                               | <b>BT Mapped (Highest Level)</b> |
| On completion of the course, the students will be able to |                                                                                               |                                  |
| CO1:                                                      | Solve engineering problems numerically using Computer Aided Finite Element Analysis packages. | Applying                         |

| <b>Mapping of COs with POs and PSOs</b>                          |     |     |     |     |     |     |
|------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|
| COs/POs                                                          | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1                                                              | 3   | 3   | 3   | 2   | -   | -   |
| CO2                                                              | 3   | 3   | 3   | 2   | -   | -   |
| CO3                                                              | -   | -   | -   | -   | -   | -   |
| CO4                                                              | -   | -   | -   | -   | -   | -   |
| CO5                                                              | -   | -   | -   | -   | -   | -   |
| avg                                                              | 3   | 3   | 3   | 2   | -   | -   |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |     |     |     |     |     |     |

|                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                      |          |   |   |   |        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|---|--------|
| PPDL2422                                                                                                                                                                                                                                                                                                                                                                                              | Product Design Laboratory                                                                                                                                                            |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                      | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                      | ESC      | 0 | 0 | 4 | 2      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                      |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                       | <ul style="list-style-type: none"><li>To give exposure to develop digital and physical prototype models using RP machine / clay models of a new product/ existing product.</li></ul> |          |   |   |   |        |
| The students in a group have to develop digital and physical prototype models using RP machine / clay models of a new product/ existing product with enhanced feature involving the following areas: <ul style="list-style-type: none"><li>Automotive components</li><li>Tool and die components</li><li>Press tool components</li><li>Consumer product</li><li>Injection moulded products.</li></ul> |                                                                                                                                                                                      |          |   |   |   |        |
| The fabricated models may be in the form of RP models, clay models, sheet metal models or cardboard models etc. The design and development of the product will be reviewed in two stages for awarding internal marks. The end semester examination mark will be based on the demonstration of the new product developed and oral examination on the same by internal examiners.                       |                                                                                                                                                                                      |          |   |   |   |        |
| Total: 60 periods                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                      |          |   |   |   |        |
| List of Equipment / Software:<br>Finite Element Analysis packages                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                      |          |   |   |   |        |

| <b>COURSE OUTCOMES:</b><br>On completion of the course, the students will be able to |                                                                                                                            | <b>BT Mapped (Highest Level)</b> |
|--------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| CO1:                                                                                 | Appreciate the use of physical prototype models for evaluating product concept                                             | Understanding                    |
| CO2                                                                                  | Apply theoretical knowledge to design and development of physical products using clay, wood, sheet metal and RP techniques | Applying                         |

| <b>Mapping of COs with POs and PSOs</b>                          |     |     |     |     |     |     |
|------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|
| COs/POs                                                          | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| CO1                                                              | 3   | 3   | 3   | 3   | 3   | -   |
| CO2                                                              | 3   | 3   | 3   | 3   | 2   | 2   |
| avg                                                              | 3   | 3   | 3   | 3   | 2.5 | 2   |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |     |     |     |     |     |     |

|                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|---|--------|
| PPDT2431                                                                                                                                                                                                                                                                                                                                                                                             | PRODUCT LIFECYCLE MANAGEMENT                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                       | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                       | PCC      | 0 | 0 | 4 | 2      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                      | <ul style="list-style-type: none"><li>To understand history, concepts and terminology of PLM</li><li>To understand functions and features of PLM/PDM</li><li>To understand different modules offered in commercial PLM/PDM tools</li><li>To demonstrate PLM/PDM approaches for industrial applications</li><li>To Use PLM/PDM with legacy data bases, CAx &amp; ERP systems</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                                                             | HISTORY, CONCEPTS AND TERMINOLOGY OF PLM                                                                                                                                                                                                                                                                                                                                              |          |   |   |   | 9      |
| Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (cPDm), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM).PLM/PDM Infrastructure – Network and Communications, Data Management, Heterogeneous data sources and applications.. |                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                                                            | PLM/PDM FUNCTIONS AND FEATURES                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   | 9      |
| User Functions – Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions – Communication and Notification, data transport, data translation, image services, system administration and application integration.                                                                        |                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                                                           | DETAILS OF MODULES IN APDM/PLM SOFTWARE                                                                                                                                                                                                                                                                                                                                               |          |   |   |   | 9      |
| Case studies based on top few commercial PLM/PDM tools                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                                                            | ROLE OF PLM IN INDUSTRIES                                                                                                                                                                                                                                                                                                                                                             |          |   |   |   | 9      |
| Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organization, users, product or service, process performance.                        |                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                                                             | BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE                                                                                                                                                                                                                                                                                                                               |          |   |   |   | 9      |
| PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                   | "Product Lifecycle Management: 21st Century Paradigm for Product Realisation" by John Stark                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                   | "Product Lifecycle Management (Volume 1): 21st Century Paradigm for Product Realisation" by John Stark                                                                                                                                                                                                                                                                                |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                   | Antti Saaksvuori and Anselmi Immonen, “Product Lifecycle Management”, Springer Publisher, 2008 (3rd Edition).                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                   | . International Journal of Product Lifecycle Management, Inderscience Publishers                                                                                                                                                                                                                                                                                                      |          |   |   |   |        |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                   | Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, “Implementing and Integrating Product Data Management and Software Configuration Management”, Artech House Publishers, 2003.                                                                                                                                                                                                |          |   |   |   |        |

|    |                                                                                                                                   |
|----|-----------------------------------------------------------------------------------------------------------------------------------|
| 4. | John Stark, “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007. |
| 5. | John Stark, “Product Lifecycle Management: 21st Century Paradigm for Product Realisation”, Springer Publisher, 2011 (2nd Edition) |
| 6. | Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006.                                                         |

| <b>COURSE OUTCOMES:<br/>The students will be able to</b> |                                                             | <b>BT Mapped<br/>(Highest Level)</b> |
|----------------------------------------------------------|-------------------------------------------------------------|--------------------------------------|
| CO1:                                                     | Summarize the history, concepts and terminology of PLM      | Understanding                        |
| CO2:                                                     | Use the functions and features of PLM/PDM                   | Applying                             |
| CO3:                                                     | Use different modules offered in commercial PLM/PDM tools   | Applying                             |
| CO4:                                                     | Implement PLM/PDM approaches for industrial applications    | Analyzing                            |
| CO5:                                                     | Integrate PLM/PDM with legacy data bases, CAx& ERP systems. | Analyzing                            |

#### Mapping of COs with POs and PSOs

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1     | 1   | 2   | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2     | 2   | 2   | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO3     | 2   | 1   | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO4     | 1   | 1   | 3   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO5     | 1   | 1   | 1   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| Avg.    | 1.4 | 1.4 | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom’s Taxonomy

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                              |          |   |   |    |        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|----|--------|
| PPDL2431                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Project Work I                                                                                                                                                                                                                                                                                                                                                                               |          |   |   |    |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                              | Category | L | T | P  | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                              | ESC      | 0 | 0 | 12 | 6      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                              |          |   |   |    |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <ul style="list-style-type: none"><li>• To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.</li><li>• To develop the methodology to solve the identified problem.</li><li>• To train the students in preparing project reports and to face reviews and viva-voce examination.</li></ul> |          |   |   |    |        |
| <ul style="list-style-type: none"><li>• The student individually works on a specific topic approved by the head of the division under the guidance of a faculty member who is familiar in this area of interest.</li><li>• The student can select any topic which is relevant to the area of engineering design.</li><li>• The topic may be theoretical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work.</li><li>• The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.</li></ul> |                                                                                                                                                                                                                                                                                                                                                                                              |          |   |   |    |        |
| Total: 180 periods                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                              |          |   |   |    |        |

|                                                           |                                                                                                                                                                                 |                                  |
|-----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| <b>COURSE OUTCOMES:</b>                                   |                                                                                                                                                                                 | <b>BT Mapped (Highest Level)</b> |
| On completion of the course, the students will be able to |                                                                                                                                                                                 |                                  |
| CO1:                                                      | At the end of the course the students will have a clear idea of their area of work and they will be in a position to carry out the remaining phase II work in a systematic way. | Applying                         |

| <b>Mapping of COs with POs and PSOs</b>                          |     |     |     |     |     |     |      |
|------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|------|
| COs/POs                                                          | PO1 | PO2 | PO3 | PO4 | PO5 | PO9 | PO12 |
| CO1                                                              | 3   | 3   | 3   | 2   | 2   | 2   | 3    |
| avg                                                              | 3   | 3   | 3   | 2   | 2   | 2   | 3    |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |     |     |     |     |     |     |      |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                               |          |   |   |    |        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|----|--------|
| PPDL2441                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Project Work II                                                                                                                                                                                               |          |   |   |    |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                               | Category | L | T | P  | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                               | ESC      | 0 | 0 | 24 | 12     |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                               |          |   |   |    |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <ul style="list-style-type: none"><li>To solve the identified problem based on the formulated methodology.</li><li>To develop skills to analyze and discuss the test results, and make conclusions.</li></ul> |          |   |   |    |        |
| <ul style="list-style-type: none"><li>The student should continue the phase I work on the selected topic as per the formulated methodology under the same supervisor.</li><li>At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department.</li><li>The students will be evaluated based on the report submitted and the viva-voce examination by a panel of examiners including one external examiner.</li></ul> |                                                                                                                                                                                                               |          |   |   |    |        |
| Total: 360 periods                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                               |          |   |   |    |        |

|                                                           |                                                                                                                                                                                    |                                  |
|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| <b>COURSE OUTCOMES:</b>                                   |                                                                                                                                                                                    | <b>BT Mapped (Highest Level)</b> |
| On completion of the course, the students will be able to |                                                                                                                                                                                    |                                  |
| CO1:                                                      | On completion of the project work students will be in a position to take up any challenging practical problem in the field of engineering design and find better solutions to it.. | Evaluating                       |

| <b>Mapping of COs with POs and PSOs</b>                          |     |     |     |     |     |     |      |
|------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|------|
| COs/POs                                                          | PO1 | PO2 | PO3 | PO4 | PO5 | PO9 | PO12 |
| CO1                                                              | 3   | 3   | 3   | 3   | 2   | 2   | 2    |
| avg                                                              | 3   | 3   | 3   | 3   | 2   | 2   | 2    |
| 1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy |     |     |     |     |     |     |      |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
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| PPDE2401                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | TRIBOLOGY IN DESIGN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | PCC      | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <ul style="list-style-type: none"><li>To study and measure the different types of surface features associated with the friction of metals and non-metals.</li><li>To study the different types of wear mechanism and surface modification techniques.</li><li>To analyze the various types of lubricants and lubrication system in the tribology.</li><li>To develop the methodology for deciding lubricants and lubrication regimes for different operating conditions.</li><li>To study the different types of high-pressure contacts and rolling bearings.</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | SURFACE INTERACTION AND FRICTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   | 9      |
| Surface Topography – Surface features-Properties and measurement – Surface interaction – Laws of friction- Adhesive Theory of Sliding Friction – Static friction -Rolling Friction – Friction in extreme conditions –Thermal considerations in sliding contact.                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | WEAR AND SURFACE TREATMENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |   |   |   | 9      |
| Types of wear mechanism – Laws of wear –Theoretical wear models- Abrasive wear – Adhesive wear – Fatigue wear – fretting wear – Cavitation wear - Wear of Metals and Nonmetals – Surface treatments – Surface modifications –Laser processing – instrumentation – International standards in friction and wear measurements                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | LUBRICANTS AND LUBRICATION REGIMES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |          |   |   |   | 9      |
| Lubricants and their physical properties- Viscosity and other properties of oils –Additives-and selection of Lubricants- Lubricants standards ISO,SAE,AGMA, BIS standards – Lubrication Regimes –Solid Lubrication- Dry and marginally lubricated contacts- Boundary Lubrication Hydrodynamic lubrication-Elasto and plasto hydrodynamic - Magneto hydrodynamic lubrication – Hydro static lubrication – Gas lubrication                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |          |   |   |   | 9      |
| Reynolds Equation-Assumptions and limitations-One and two dimensional Reynolds Equation Reynolds and Sommerfeld boundary conditions- Pressure wave, flow, load capacity and friction calculations in Hydrodynamic bearings-Long and short bearings-Pad bearings and Journal bearings-Squeeze film effects- Thermal considerations-Hydrostatic lubrication of Pad bearing Pressure, flow, load and friction calculations- Stiffness considerations- Various types of flow restrictors in hydro static bearings. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |   |   |   | 9      |
| Rolling contacts of Elastic solids- contact stresses – Hertzian stress equation- Spherical and cylindrical contacts-Contact Fatigue life- Oil film effects- Elasto Hydrodynamic lubrication Theory Soft and hard EHL Reynolds equation for elasto hydrodynamic lubrication- - Film shape within and outside contact zones-Film thickness and friction calculation- Rolling bearings- Stresses and deflections-Traction drives.                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | "Fundamentals of Tribology" by B. C. Majumdar and A. S. K. Bhattacharya                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | "Introduction to Tribology" by Bharat Bhushan                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |

| <b>REFERENCES:</b> |                                                                                                                    |
|--------------------|--------------------------------------------------------------------------------------------------------------------|
| 1.                 | Rabinowicz.E, “Friction and Wear of materials”, John Willey & Sons ,UK,1995                                        |
| 2.                 | Cameron, A. “Basic Lubrication Theory”, Ellis Herward Ltd., UK, 1981.                                              |
| 3.                 | Halling, J. (Editor) – “Principles of Tribology “, Macmillian – 1984                                               |
| 4.                 | Williams J.A. “Engineering Tribology”, Oxford Univ. Press, 1994                                                    |
| 5.                 | S.K.Basu, S.N.Sengupta & B.B.Ahuja ,”Fundamentals of Tribology”, Prentice –Hall of India Pvt Ltd , New Delhi, 2005 |
| 6.                 | G.W.Stachowiak& A.W .Batchelor , Engineering Tribology, Butterworth - Heinemann, UK, 2005                          |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                     |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------------|-----------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                          | Selecting the different machine tool mechanisms.    |     |     |     |     |     |     |     |     |      |      | Analysing                    |      |      |
| CO2:                                                                          | Designing the Multi speed Gear Box and feed drives. |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| CO3:                                                                          | Designing the machine tool structures               |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| CO4:                                                                          | Designing the guideways and power screws.           |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| CO5:                                                                          | Designing the spindles and bearings.                |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| Mapping of COs with POs and PSOs                                              |                                                     |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/POs                                                                       | PO1                                                 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                           | 1                                                   | 1   | 1   | 2   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                           | 1                                                   | 1   | 1   | 2   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                           | 1                                                   | 1   | 1   | 2   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                           | 1                                                   | 1   | 1   | 2   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                           | 1                                                   | 1   | 1   | 2   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                          | 1                                                   | 1   | 1   | 2   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial BT – Bloom’s Taxonomy               |                                                     |     |     |     |     |     |     |     |     |      |      |                              |      |      |

|                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|---|--------|
| PPDE2402                                                                                                                                                                                                                                         | ADVANCED MACHINE TOOL DESIGN                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
|                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                       | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                       | PCC      | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                                                                                  | <ul style="list-style-type: none"><li>• Selecting the different machine tool mechanisms.</li><li>• Designing the Multi speed Gear Box and feed drives.</li><li>• Designing the machine tool structures.</li><li>• Designing the guide ways and power screws.</li><li>• Designing the spindles and bearings.</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                         | INTRODUCTION TO MACHINE TOOL DESIGN                                                                                                                                                                                                                                                                                   |          |   |   |   | 9      |
| Introduction to Machine Tool Drives and Mechanisms, Auxiliary Motions in Machine Tools, Kinematics of Machine Tools, Motion Transmission.                                                                                                        |                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                        | REGULATION OF SPEEDS AND FEEDS                                                                                                                                                                                                                                                                                        |          |   |   |   | 9      |
| Aim of Speed and Feed Regulation, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations, Design of Speed Gear Boxes, Feed Drives, Feed Box Design.                                                         |                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                       | DESIGN OF MACHINE TOOL STRUCTURES                                                                                                                                                                                                                                                                                     |          |   |   |   | 9      |
| Functions of Machine Tool Structures and their Requirements, Design for Strength, Design for Rigidity, Materials for Machine Tool Structures, Machine Tool Constructional Features, Beds and Housings, Columns and Tables, Saddles and Carriage. |                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                        | DESIGN OF GUIDEWAYS AND POWER SCREWS                                                                                                                                                                                                                                                                                  |          |   |   |   | 9      |
| Functions and Types of Guideways, Design of Guideways, Design of Aerostatic Slide ways, Design of Anti-Friction Guideways, Combination Guideways, Design of Power Screws.                                                                        |                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                         | DESIGN OF SPINDLES AND SPINDLE SUPPORT                                                                                                                                                                                                                                                                                |          |   |   |   | 9      |
| Functions of Spindles and Requirements, Effect of Machine Tool Compliance on Machining Accuracy, Design of Spindles, Antifriction Bearings. Dynamics of Machine Tools: Machine Tool Elastic System, Static and Dynamic Stiffness.                |                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                               | "Machine Tool Design and Numerical Control" by N.K. Mehta.                                                                                                                                                                                                                                                            |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                               | "Design of Machine Tools" by P. C. Sharma.                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                               | N.K. Mehta, Machine Tool Design and Numerical Control, TMH, New Delhi, 3rd edition 2012.                                                                                                                                                                                                                              |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                               | G.C. Sen and A. Bhattacharya, Principles of Machine Tools, New Central Book Agency, 2015.                                                                                                                                                                                                                             |          |   |   |   |        |
| 3.                                                                                                                                                                                                                                               | K Pal, S. K. Basu, “Design of Machine Tools”, 6th Edition. Oxford IBH, 2014.                                                                                                                                                                                                                                          |          |   |   |   |        |
| 4.                                                                                                                                                                                                                                               | N. S. Acherkhan, “Machine Tool Design”, Volume 2 University Press of the Pacific, 2000.                                                                                                                                                                                                                               |          |   |   |   |        |
| 5.                                                                                                                                                                                                                                               | F. Koenigsberger, Design Principles of Metal-Cutting Machine Tools, Pergamon Press, 1964.                                                                                                                                                                                                                             |          |   |   |   |        |
| 6.                                                                                                                                                                                                                                               | F. Koenigsberger, Machine Tool Structures, Pergamon Press, 1970.                                                                                                                                                                                                                                                      |          |   |   |   |        |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                  |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------------|--------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                          | Select the different machine tool mechanisms.    |     |     |     |     |     |     |     |     |      |      | Analysing                    |      |      |
| CO2:                                                                          | Design the Multi speed Gear Box and feed drives. |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| CO3:                                                                          | Design the machine tool structures.              |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| CO4:                                                                          | Design the guideways and power screws.           |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| CO5:                                                                          | Design the spindles and bearings.                |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| Mapping of COs with POs and PSOs                                              |                                                  |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/POs                                                                       | PO1                                              | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                           | 3                                                | 3   | 3   | 2   | -   | 3   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                           | 3                                                | 3   | 3   | 2   | -   | 3   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                           | 3                                                | 3   | 3   | 2   | -   | 3   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                           | 3                                                | 3   | 3   | 2   | -   | 3   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                           | 3                                                | 3   | 3   | 2   | -   | 3   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                          | 3                                                | 3   | 3   | 2   | -   | 3   | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial BT – Bloom’s Taxonomy               |                                                  |     |     |     |     |     |     |     |     |      |      |                              |      |      |

|                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|---|--------|
| PPDE2403                                                                                                                                                                                                                                                                                          | GENERATIVE DESIGN AND TOPOLOGY OPTIMIZATION                                                                                                                                                                                                                                                                                                                               |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                           | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                           | PCC      | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                   | <ul style="list-style-type: none"><li>To impart knowledge on basic concepts in generative design.</li><li>To develop design methods to meet the needs of a customer.</li><li>To incorporate various design methods to develop a creative product.</li><li>To gain knowledge on topology aspects of design.</li><li>To gain knowledge on optimization in design.</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                          | INTRODUCTION                                                                                                                                                                                                                                                                                                                                                              |          |   |   |   | 9      |
| Introduction to Generative design - Benefits of generative design -Design exploration Examine multiple design options and review tradeoffs in materials. Performance, and manufacturing methods.                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                         | GENERATIVE DESIGN                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   | 9      |
| Editable geometry - Integrated workflows- Multiple manufacturing methods- Additive – 3 or 5 axis milling – Applications.                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                        | LOW-DENSITY AREAS IN TOPOLOGY OPTIMIZATION                                                                                                                                                                                                                                                                                                                                |          |   |   |   | 9      |
| Localized mode in low-density areas - Localized deformation, Polynomial interpolation model, Breakdown issue in ESO. Dynamics – analysis and topology optimization under harmonic and random force excitations, Thermo-elastic problems - topology optimization in single and multiple materials. |                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                         | INTEGRATED LAYOUT AND TOPOLOGY OPTIMIZATION                                                                                                                                                                                                                                                                                                                               |          |   |   |   | 9      |
| Introduction to integrated optimization, Finite-circle method, Density points and embedded, meshing, MPC-based component-structure connections, integrated optimization based on implicit model.                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                          | POTENTIAL APPLICATIONS OF TOPOLOGY OPTIMIZATION                                                                                                                                                                                                                                                                                                                           |          |   |   |   | 9      |
| Shape-preserving design, Smart structure design, Structural features design, Topology optimization and additive manufacturing.                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                | "Generative Design: Architecture and Material Technology" by Behnam D. and R. J. P. de G.                                                                                                                                                                                                                                                                                 |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                | "Topology Optimization: Theory, Methods, and Applications" by Martin P. Bendsoe and Nikolaj A. Sigmund.                                                                                                                                                                                                                                                                   |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                | Martin Philip Bendsoe, Ole Sigmund, “Topology Optimization: Theory, Methods, and Applications”, Springer Science & Business Media, 2003.                                                                                                                                                                                                                                  |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                | Eris, Ozgur, “Effective Inquiry for Innovative Engineering Design”, Springer,2004.                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
| 3.                                                                                                                                                                                                                                                                                                | George I. N. Rozvany, Tomasz LewinskiTopology “Optimization in Structural and Continuum Mechanics”. Springer; 2015 edition.                                                                                                                                                                                                                                               |          |   |   |   |        |
| 4.                                                                                                                                                                                                                                                                                                | Gregoire Allaire “Shape Optimization by the Homogenization Method” SpringerVerlag New York 2002.                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| 5.                                                                                                                                                                                                                                                                                                | Behrooz Hassani, Ernest Hinton “Homogenization and Structural Topology Optimization” Springer-Verlag London, 1999.                                                                                                                                                                                                                                                        |          |   |   |   |        |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                                                                       |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                          | Appreciate the aspects of need for design, design process used for designing various components       |     |     |     |     |     |     |     |     |      |      | Understanding                |      |      |
| CO2:                                                                          | Get familiarized with concepts related to design methods during the design of products.               |     |     |     |     |     |     |     |     |      |      | Understanding                |      |      |
| CO3:                                                                          | Get acquainted with the knowledge of designing creative components.                                   |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO4:                                                                          | Gain knowledge on topology aspects of design.                                                         |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO5:                                                                          | Get equipped with optimization tools for improving quality, reliability and performance of a product. |     |     |     |     |     |     |     |     |      |      | Analyzing                    |      |      |
| Mapping of COs with POs and PSOs                                              |                                                                                                       |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/POs                                                                       | PO1                                                                                                   | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                           | 1                                                                                                     | 2   | 3   | 4   | 5   | 6   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                           | 3                                                                                                     | 3   | 3   | 3   | 3   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                           | 3                                                                                                     | 3   | 3   | 3   | 3   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                           | 3                                                                                                     | 3   | 3   | 3   | 3   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                           | 3                                                                                                     | 3   | 3   | 3   | 3   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                          | 3                                                                                                     | 3   | 3   | 3   | 3   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial BT – Bloom’s Taxonomy               |                                                                                                       |     |     |     |     |     |     |     |     |      |      |                              |      |      |

|                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                |          |   |   |   |        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|---|--------|
| PPDE2404                                                                                                                                                                                                                                                                      | DATA ANALYTICS                                                                                                                                                                                                 |          |   |   |   |        |
|                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                | PCC      | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                |          |   |   |   |        |
|                                                                                                                                                                                                                                                                               | <ul style="list-style-type: none"><li>Recognize the importance of data analytics</li><li>Exhibit competence on data analytics packages</li><li>Apply solution methodologies for industrial problems.</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                      | INTRODUCTION                                                                                                                                                                                                   |          |   |   |   | 9      |
| Introduction to Multivariate Statistics-Degree of Relationship among Variables-Review of Univariate and Bivariate Statistics-Screening Data Prior to Analysis-Missing Data, Outliers, Normality, Linearity, and Homoscedasticity.                                             |                                                                                                                                                                                                                |          |   |   |   |        |
|                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                     | MULTIPLE REGRESSION                                                                                                                                                                                            |          |   |   |   | 9      |
| Multiple Regression- Linear and Nonlinear techniques- Backward-Forward-Stepwise Hierarchical regression-Testing interactions (2way interaction) - Analysis of Variance and Covariance (ANOVA & ANCOVA) - Multivariate Analysis of Variance and Covariance (MANOVA & MANCOVA). |                                                                                                                                                                                                                |          |   |   |   |        |
|                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                    | LOGISTIC REGRESSION                                                                                                                                                                                            |          |   |   |   | 9      |
| Regression with binary dependent variable -Simple Discriminant Analysis Multiple Discriminant analysis-Assessing classification accuracy- Conjoint analysis (Full profile method).                                                                                            |                                                                                                                                                                                                                |          |   |   |   |        |
|                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                     | PRINCIPAL COMPONENT ANALYSIS                                                                                                                                                                                   |          |   |   |   | 9      |
| Principal Component Analysis -Factor Analysis- Orthogonal and Oblique Rotation-Factor Score Estimation-Multidimensional Scaling-Perceptual Map-Cluster Analysis (Hierarchical Vs Nonhierarchical Clustering).                                                                 |                                                                                                                                                                                                                |          |   |   |   |        |
|                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                      | LATENT VARIABLE MODELS                                                                                                                                                                                         |          |   |   |   | 9      |
| Latent Variable Models an Introduction to Factor, Path, and Structural Equation Analysis- Time series data analysis (ARIMA model) – Decision tree analysis (CHAID, CART) - Introduction to Big Data Management.                                                               |                                                                                                                                                                                                                |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                            | "Data Analytics: Models and Algorithms for Intelligent Data Analysis" by Thomas A. Runkler                                                                                                                     |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                            | "Practical Data Science with R" by Nina Zumel and John Mount                                                                                                                                                   |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                            | Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. “Multivariate data analysis”, (7th edition). Pearson India. 2015                                                                     |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                            | Tabachnick, B. G., & Fidell, L. S., “Using multivariate statistics”, (5th edition). Pearson Prentice Hall, 2001                                                                                                |          |   |   |   |        |
| 3.                                                                                                                                                                                                                                                                            | Gujarati, D. N. , “Basic econometrics”, Tata McGraw-Hill Education, 2012                                                                                                                                       |          |   |   |   |        |
| 4.                                                                                                                                                                                                                                                                            | Malhotra, N. K., “ Marketing research: An applied orientation”, 5/e. Pearson Education India, 2008                                                                                                             |          |   |   |   |        |
| 5.                                                                                                                                                                                                                                                                            | Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. “ Applied multiple regression/correlation analysis for the behavioral sciences”, Routledge., 2013                                                            |          |   |   |   |        |
| 6.                                                                                                                                                                                                                                                                            | Han, J., Kamber, M., & Pei, J. “Data mining: concepts and techniques: concepts and techniques”, Elsevier, 2011.                                                                                                |          |   |   |   |        |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                                      |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------------|----------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                          | To recognize the importance of data analytics.                       |     |     |     |     |     |     |     |     |      |      | Understanding                |      |      |
| CO2:                                                                          | To Exhibit competence on data analytics packages.                    |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO3:                                                                          | To apply solution methodologies for industrial problems.             |     |     |     |     |     |     |     |     |      |      | Analyzing                    |      |      |
| CO4:                                                                          | To Perform Principal Component Analysis to visualize and group data. |     |     |     |     |     |     |     |     |      |      | Analyzing                    |      |      |
| CO5:                                                                          | Understand and apply latent variable models                          |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| Mapping of COs with POs and PSOs                                              |                                                                      |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/POs                                                                       | PO1                                                                  | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                           | 1                                                                    | 1   | 1   | 1   | 1   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                           | 1                                                                    | 1   | 1   | 1   | 1   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                           | 1                                                                    | 1   | 1   | 1   | 1   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                           | -                                                                    | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                           | -                                                                    | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                          | 1                                                                    | 1   | 1   | 1   | 1   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial BT – Bloom’s Taxonomy               |                                                                      |     |     |     |     |     |     |     |     |      |      |                              |      |      |

|                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|---|--------|
| PPDE2405                                                                                                                                                                                                                                                                                                                              | INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS                                                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                            | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                            | PCC      | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                       | <ul style="list-style-type: none"><li>To appreciate the need and scope for robotics and to understand the principles of robot kinematics</li><li>To design the drive systems and its control</li><li>To understand the principles of sensors and vision systems</li><li>To envision the industrial applications of robots and its safety</li><li>To gain knowledge on artificial intelligence and expert systems</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                              | INTRODUCTION AND ROBOT KINEMATICS                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   | 9      |
| Definition need and scope of Industrial robots– Robot anatomy – Work volume – Precision movement – End effectors – Sensors. Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects                                  |                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                             | ROBOT DRIVES AND CONTROL                                                                                                                                                                                                                                                                                                                                                                                                   |          |   |   |   | 9      |
| Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.                  |                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                            | ROBOT SENSORS                                                                                                                                                                                                                                                                                                                                                                                                              |          |   |   |   | 9      |
| Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system.        |                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                             | ROBOT CELL DESIGN AND APPLICATION                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   | 9      |
| Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis. Industrial application of robots.                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                              | ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE 9 AND EXPERT SYSTEMS                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   | 9      |
| Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation. Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques– problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots. |                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                    | "Industrial Robotics: Technology, Programming, and Applications" by John M. Jordan and M. Michael K.                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                    | "Expert Systems: Principles and Programming" by Joseph C. Giarratano and Gary D. Riley                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                    | K.S.Fu, Gonzalez, R.C. and Lee, C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill, 1987                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                    | Koren,Y., “Robotics for Engineers”, McGraw-Hill, 1987.                                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
| 3.                                                                                                                                                                                                                                                                                                                                    | Kozyrey, Yu. “Industrial Robots”, MIR Publishers Moscow, 1985.                                                                                                                                                                                                                                                                                                                                                             |          |   |   |   |        |

|    |                                                                                                                                           |
|----|-------------------------------------------------------------------------------------------------------------------------------------------|
| 4. | Klafter,R.D., Chmielewski, T.A. and Negin,M., “Robotics Engineering – An Integrated Approach”,Prentice-Hall of India Pvt. Ltd., 1984      |
| 5. | Deb, S.R.”Robotics Technology and Flexible Automation”, Tata McGraw-Hill, 1994                                                            |
| 6. | Groover,M.P., Weis,M., Nagel,R.N. and Odrey,N.G., “Industrial Robotics Technology, Programming and Applications”, McGraw-Hill, Int., 1986 |
| 7. | Jordanides,T. and Torby,B.J., ,”Expert Systems and Robotics“, Springer –Verlag, New York, May 1991                                        |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                                        |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |               |      |  |
|-------------------------------------------------------------------------------|------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|---------------|------|--|
| CO1:                                                                          | Understand robot kinematics.                                           |     |     |     |     |     |     |     |     |      |      |                              | Understanding |      |  |
| CO2:                                                                          | Incorporate mechanical components and concepts in robotics             |     |     |     |     |     |     |     |     |      |      |                              | Applying      |      |  |
| CO3:                                                                          | Understand the basics of various sensors to effectively design a robot |     |     |     |     |     |     |     |     |      |      |                              | Understanding |      |  |
| CO4:                                                                          | Design suitable robots for specific applications                       |     |     |     |     |     |     |     |     |      |      |                              | Creating      |      |  |
| CO5:                                                                          | Optimize the robots using Artificial Intelligence                      |     |     |     |     |     |     |     |     |      |      |                              | Creating      |      |  |
| Mapping of COs with POs and PSOs                                              |                                                                        |     |     |     |     |     |     |     |     |      |      |                              |               |      |  |
| COs/Pos                                                                       | PO1                                                                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1          | PSO2 |  |
| CO1                                                                           | 1                                                                      | 3   | 3   | -   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -             | -    |  |
| CO2                                                                           | 1                                                                      | 3   | 3   | -   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -             | -    |  |
| CO3                                                                           | 1                                                                      | 3   | 3   | -   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -             | -    |  |
| CO4                                                                           | 1                                                                      | 3   | 3   | -   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -             | -    |  |
| CO5                                                                           | 1                                                                      | 3   | 3   | -   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -             | -    |  |
| Avg.                                                                          | 1                                                                      | 3   | 3   | -   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -             | -    |  |
| 1 – Slight, 2 – Moderate, 3 – Substantial BT – Bloom’s Taxonomy               |                                                                        |     |     |     |     |     |     |     |     |      |      |                              |               |      |  |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|---|--------|
| PPDE2406                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | ENGINEERING FRACTURE MECHANICS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | PCC      | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <ul style="list-style-type: none"><li>Formulation of governing equations for elastic problems</li><li>Stresses calculations/displacements around the crack tip for different modes of fracture</li><li>Estimation of K1c/SIF/critical flaws/failure stresses for different crack geometries</li><li>Life assessment of the cracked components under different types of repeated/variable fatigue loads and design for its life extension.</li><li>Analysis of failed engineering components under different modes of fracture.</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | ELEMENTS OF SOLID MECHANICS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |   |   |   | 9      |
| Introduction to Failure and Fracture- Spectacular Failures-Basics Principles-Governing equations for the deformable body-Stress-Strain relations and general equations of elasticity in Cartesian and Polar Coordinates-vectors and tensors-differential equations of equilibrium-compatibility boundary conditions-representation of three-dimensional stress system -generalized hook's law – plane stress and stain problems - Airy's stress function. Methods of formulation of Governing Differential equations for plane elasticity-Naviers Equation-Biharmonic equation in Cartesian and polar coordinates. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | STRESS AND DISPLACEMENT AROUND THE CRACK TIP FOR DIFFERENT MODES OF FRACTURE                                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |   |   |   | 9      |
| Brittle and Ductile Fracture-Modes of Fracture-Weakness of the components due to Flaws-Need for Linear Elastic Fracture Mechanics (LEFM) – Evaluation of Structural Design-Stress and displacement around the crack tip in K-annulus for Mode-I and Mode-II plane crack problems – Stress and displacement around the crack tip in K-annulus for Mode III crack problems.                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | STATIONARY CRACK UNDER STATIC LOADING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   | 9      |
| Griffith analysis- Irwin’s approximation-CTOD and stress ahead of the crack tip- Westergaard solutions: Analytical Calculations for SIF for different crack geometries-Critical crack length and fracture stress calculations. Two dimensional elastic fields – Analytical solutions for small scale yielding near a crack front – plastic zone size –Specimen size calculations: K1c Testing for Fracture toughness of the Material.                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | FATIGUE FAILURE AND ENVIRONMENTAL-ASSISTED FRACTURE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |          |   |   |   | 9      |
| Introduction to fatigue failure-S-N Curve-Crack Initiation-Crack propagation- Effect of an Overload-Variable amplitude Fatigue load-Crack closure- Characteristics of fatigue crack-Paris Law- Fatigue Crack Growth Test to evaluate Paris constants- life calculations for a given load amplitude –effects of changing the load spectrum Environmental-assisted Fracture-Micro mechanisms-factors influencing Environmental-assisted fracture-Environment-assisted Fatigue Failure affecting fatigue performance, fatigue loading, constant and variable amplitude loading.                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | APPLICATIONS OF FRACTURE MECHANICS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   | 9      |
| J-integral, Mixed-mode fracture, Crack arrest methodologies - Case studies: Analysis on failedcomponents and design for the extension of its life                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | "Fracture Mechanics: Fundamentals and Applications" by Ted L. Anderson                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | "Introduction to Fracture Mechanics" by Steven A. Suresh                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |   |   |   |        |

| <b>REFERENCES:</b> |                                                                                                                              |
|--------------------|------------------------------------------------------------------------------------------------------------------------------|
| 1.                 | Broek, David, "Elementary Engineering Fracture Mechanics ", Springer Netherlands, 1982.                                      |
| 2.                 | John M. Barson and Stanely T. Rolfe, "Fatigue and fracture control in structures", Butterworth-Heinemann; 3rd edition. 1999. |
| 3.                 | Kare Hellan, "Introduction of Fracture Mechanics", McGraw-Hill Book Company, 1985                                            |
| 4.                 | Prashant Kumar, "Elements of Fracture Mechanics", Tata McGraw-Hill Publishing Company Ltd, 2009.                             |
| 5.                 | Deb, S.R. "Robotics Technology and Flexible Automation", Tata McGraw-Hill, 1994                                              |
| 6.                 | Ted L. Anderson, "Fracture Mechanics: Fundamentals and Applications", CRC Taylor and Francis, 4th Edition, 2017.             |
| 7.                 | Tribikram Kundu, "Fundamentals of Fracture Mechanics", Ane Books Pvt. Ltd. New Delhi/ CRC Press, 1st Indian Reprint, 2012    |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                                                                                                       |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                          | Formulate governing equation for elastic problems                                                                                     |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| CO2:                                                                          | Calculate stresses/displacements around the crack tip for different modes of fracture                                                 |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO3:                                                                          | Estimate K <sub>Ic</sub> /SIF/critical flaws/failure stresses for different crack geometries                                          |     |     |     |     |     |     |     |     |      |      | Analyzing                    |      |      |
| CO4:                                                                          | Assess the life of the cracked components under different types of repeated/variable fatigue loads and design for its life extension. |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| CO5:                                                                          | Analyze failed engineering components under different modes of fracture.                                                              |     |     |     |     |     |     |     |     |      |      | Analyzing                    |      |      |
| Mapping of COs with POs and PSOs                                              |                                                                                                                                       |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/Pos                                                                       | PO1                                                                                                                                   | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                           | 1                                                                                                                                     | 1   | 1   | 2   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                           | 1                                                                                                                                     | 1   | 1   | 2   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                           | 1                                                                                                                                     | 1   | 1   | 2   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                           | 1                                                                                                                                     | 1   | 1   | 2   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                           | 1                                                                                                                                     | 1   | 1   | 2   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                          | 5                                                                                                                                     | 5   | 5   | 10  | 10  | 5   | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial BT – Bloom’s Taxonomy               |                                                                                                                                       |     |     |     |     |     |     |     |     |      |      |                              |      |      |

|                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|---|--------|
| PPDE2407                                                                                                                                                                                                                                         | ENTERPRISE RESOURCE PLANNING AND MANAGEMENT                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
|                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                        | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                        | PCC      | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
|                                                                                                                                                                                                                                                  | <ul style="list-style-type: none"><li>Students will be able to identify the needs of Enterprise resource planning.</li><li>Students will be able to understand the various technologies of ERP.</li><li>Students will be able to distinguish the various ERP packages.</li><li>Students will be able to understand the various architecture of ERP.</li><li>Students will be able to identify the issues in ERP procurement.</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                         | ENTERPRISE RESOURCE PLANNING AND VALUECHAIN MANAGEMENT                                                                                                                                                                                                                                                                                                                                                                                 |          |   |   |   | 9      |
| Principle – ERP framework – Business Blue Print – Business Engineering vs Business process Re-Engineering – Tools – Languages – Value chain – Supply and Demand chain – Extended supply chain management – Dynamic Models – Process Models       |                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
|                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                        | TECHNOLOGY AND ARCHITECTURE                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   | 9      |
| Client/Server architecture – Technology choices – Internet direction – Evaluation framework – CRM – CRM pricing–chain safety – Evaluation framework.                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
|                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                       | ERP SYSTEMPACKAGES                                                                                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   | 9      |
| SAP, People soft, Baan and Oracle – Comparison – Integration of different ERP applications – ERP as sales force automation – Integration of ERP and Internet – ERP Implementation strategies – Organizational and social issues.                 |                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
|                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                        | ERP ARCHITECTUR                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   | 9      |
| Overview – Architecture – AIM – applications – Oracle SCM.SAP: Overview – Architecture – applications - Before and after Y2k – critical issues – Training on various modules of IBCS ERP Package-Oracle ERP and MAXIMO, including ERP on the NET |                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
|                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                         | ERP PROCUREMENT ISSUES                                                                                                                                                                                                                                                                                                                                                                                                                 |          |   |   |   | 9      |
| Market Trends – Outsourcing ERP – Economics – Hidden Cost Issues – ROI – Analysis of cases from five Indian Companies.                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
|                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                               | "Enterprise Resource Planning: Concepts, Methodologies, Tools, and Applications" by Stefanos Zenios and K. P. Chaurasia                                                                                                                                                                                                                                                                                                                |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                               | "Enterprise Resource Planning (ERP): The Dynamics of Operations Management" by Dinesh S. M. and P. A. Azee                                                                                                                                                                                                                                                                                                                             |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                               | ERPWARE, ERP Implementation Framework, Garg & Venkitakrishnan, Prentice Hall, 1999                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                               | Jose Antonio Fernandez , The SAP R/3 Handbook, Tata Mcgraw Hill, 1998.                                                                                                                                                                                                                                                                                                                                                                 |          |   |   |   |        |
| 3.                                                                                                                                                                                                                                               | Sadagopan.S , ERP-A Managerial Perspective, Tata Mcgraw Hill, 1999.                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |        |
| 4.                                                                                                                                                                                                                                               | Thomas E Vollmann and BeryWhybark , Manufacturing and Control Systems, Galgothia Publications, 1998.                                                                                                                                                                                                                                                                                                                                   |          |   |   |   |        |
| 5.                                                                                                                                                                                                                                               | Vinod Kumar Crag and N.K.Venkitakrishnan ,Enterprise Resource Planning – Concepts and Practice, Prentice Hall of India, 1998.                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                                                                                                                                                          |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                          | Able to acquire integrated view of the various facets of business, including planning, manufacturing, sales, finance and marketing.                                                      |     |     |     |     |     |     |     |     |      |      | Understanding                |      |      |
| CO2:                                                                          | Able to understand the development of software to integrate business activities such as inventory management and control, order tracking, customer service, finance and human resources. |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO3:                                                                          | Awareness on the software applications and tools that are available to business to use to drive out costs and improve efficiency.                                                        |     |     |     |     |     |     |     |     |      |      | Understanding                |      |      |
| CO4:                                                                          | Understand the architecture of various ERP packages available in the market.                                                                                                             |     |     |     |     |     |     |     |     |      |      | Understanding                |      |      |
| CO5:                                                                          | Ability to learn the outsourcing concepts of ERP and its economics.                                                                                                                      |     |     |     |     |     |     |     |     |      |      | Analyzing                    |      |      |
| Mapping of COs with POs and PSOs                                              |                                                                                                                                                                                          |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/Pos                                                                       | PO1                                                                                                                                                                                      | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                           | 2                                                                                                                                                                                        | 2   | 2   | 2   | 2   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                           | 2                                                                                                                                                                                        | 2   | 2   | 2   | 2   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                           | 2                                                                                                                                                                                        | 2   | 2   | 2   | 2   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                           | 2                                                                                                                                                                                        | 2   | 2   | 2   | 2   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                           | 2                                                                                                                                                                                        | 2   | 2   | 2   | 2   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                          | 2                                                                                                                                                                                        | 2   | 2   | 2   | 2   | 2   | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial BT – Bloom’s Taxonomy               |                                                                                                                                                                                          |     |     |     |     |     |     |     |     |      |      |                              |      |      |

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| PPDE2408                                                                                                                                                                                                                                                                                                                                                                      | ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |                   |
|                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                    | Category | L | T | P | Credit            |
|                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                    | PCC      | 3 | 0 | 0 | 3                 |
| Course objectives                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |                   |
|                                                                                                                                                                                                                                                                                                                                                                               | <ul style="list-style-type: none"><li>To gain knowledge on artificial intelligence.</li><li>To understand the concepts of Machine Learning.</li><li>To appreciate supervised learning and their applications.</li><li>To appreciate the concepts and algorithms of unsupervised learning.</li><li>To understand the theoretical and practical aspects of Probabilistic Graphical Models.</li></ul> |          |   |   |   |                   |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                                      | ARTIFICIAL INTELLIGENCE                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   | 9                 |
| Artificial intelligence – Basics – Goals of artificial intelligence– AI techniques–problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |                   |
|                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |                   |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                                     | INTRODUCTION TO MACHINE LEARNING                                                                                                                                                                                                                                                                                                                                                                   |          |   |   |   | 9                 |
| Machine Learning–Types of Machine Learning –Machine Learning process- preliminaries, testing Machine Learning algorithms, turning data into Probabilities, and Statistics for Machine Learning Probability theory – Probability Distributions – Decision Theory.                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |                   |
|                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |                   |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                                    | SUPERVISED LEARNING                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   | 9                 |
| Linear Models for Regression – Linear Models for Classification- Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models – Decision Tree Learning – Bayesian Learning, Naïve Bayes – Ensemble Methods, Bagging, Boosting, Neural Networks, Multilayer Perceptron, Feed-forward Network, Error Back propagation - Support Vector Machines |                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |                   |
|                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |                   |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                                     | UNSUPERVISED LEARNING                                                                                                                                                                                                                                                                                                                                                                              |          |   |   |   | 9                 |
| Clustering- K-means – EM Algorithm- Mixtures of Gaussians –Dimensionality Reduction, Linear Discriminant Analysis, Factor Analysis, Principal Components Analysis, Independent Components Analysis.                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |                   |
|                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |                   |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                                      | PROBABILISTIC GRAPHICAL MODELS                                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   | 9                 |
| Graphical Models – Undirected Graphical Models – Markov Random Fields – Directed Graphical Models – Bayesian Networks – Conditional Independence properties – Markov Random Fields Hidden Markov Models – Conditional Random Fields (CRFs).                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |                   |
|                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   | Total: 45 periods |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |                   |
| 1.                                                                                                                                                                                                                                                                                                                                                                            | Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig                                                                                                                                                                                                                                                                                                                     |          |   |   |   |                   |
| 2.                                                                                                                                                                                                                                                                                                                                                                            | "Pattern Recognition and Machine Learning" by Christopher M. Bishop                                                                                                                                                                                                                                                                                                                                |          |   |   |   |                   |
| REFERENCES:                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   |                   |
| 1.                                                                                                                                                                                                                                                                                                                                                                            | Christopher Bishop, “Pattern Recognition and Machine Learning” Springer, 2007                                                                                                                                                                                                                                                                                                                      |          |   |   |   |                   |
| 2.                                                                                                                                                                                                                                                                                                                                                                            | Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Chapman and Hall, CRC Press, Second Edition,2014.                                                                                                                                                                                                                                                                               |          |   |   |   |                   |
| 3.                                                                                                                                                                                                                                                                                                                                                                            | Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.                                                                                                                                                                                                                                                                                                                 |          |   |   |   |                   |
| 4.                                                                                                                                                                                                                                                                                                                                                                            | Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Third Edition, 2014.                                                                                                                                                                                                                                                                                                                |          |   |   |   |                   |
| 5.                                                                                                                                                                                                                                                                                                                                                                            | Tom Mitchell, “Machine Learning”, McGraw-Hill,1997.                                                                                                                                                                                                                                                                                                                                                |          |   |   |   |                   |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                                                                                             |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                          | Optimize the robots using Artificial Intelligence.                                                                          |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| CO2:                                                                          | Design a learning model appropriate to the application.                                                                     |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| CO3:                                                                          | Implement Probabilistic Discriminative and Generative algorithms for an application of your choice and analyze the results. |     |     |     |     |     |     |     |     |      |      | Analyzing                    |      |      |
| CO4:                                                                          | Use a tool to implement typical Clustering algorithms for different types of applications.                                  |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO5:                                                                          | Identify applications suitable for different types of Machine Learning with suitable justification.                         |     |     |     |     |     |     |     |     |      |      | Evaluating                   |      |      |
| Mapping of COs with POs and PSOs                                              |                                                                                                                             |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/Pos                                                                       | PO1                                                                                                                         | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                           | 2                                                                                                                           | 1   | 1   | 2   | 1   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                           | 2                                                                                                                           | 1   | 1   | 2   | 1   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                           | 2                                                                                                                           | 1   | 1   | 2   | 1   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                           | 2                                                                                                                           | 1   | 1   | 2   | 1   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                           | 2                                                                                                                           | 1   | 1   | 2   | 1   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                          | 2                                                                                                                           |     | 1   | 2   | 1   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial BT – Bloom’s Taxonomy               |                                                                                                                             |     |     |     |     |     |     |     |     |      |      |                              |      |      |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
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| PPDE2409                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | DESIGN FOR ADDITIVE MANUFACTURING                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | PCC      | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <ul style="list-style-type: none"><li>• To acquaint the students with evolution of Additive Manufacturing (AM).</li><li>• To gain knowledge on Design aspects of Additive Manufacturing (DFAM).</li><li>• To acquaint with Photo polymerization and Sintering processes and their applications.</li><li>• To acquaint the students with applications aspects of Additive Manufacturing.</li><li>• To gain knowledge in Future trends of Additive Manufacturing</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | BASICS PRINCIPLES OF ADDITIVE MANUFACTURING                                                                                                                                                                                                                                                                                                                                                                                                                              |          |   |   |   | 9      |
| Introduction to the Basic Principles of Additive Manufacturing, Additive Manufacturing Processes, Extrusion, Beam Deposition                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | DESIGN CONCEPTS IN ADDITIVE MANUFACTURING                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   | 9      |
| Design/Fabrication Processes: Data Sources, Software Tools, File Formats, Model Repair and Validation, Pre- & Post-processing, Designing for Additive Manufacturing, Multiple Materials, Hybrids, Composite Materials, current and future directions.                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | DESIGN FOR ADDITIVE MANUFACTURING                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   | 9      |
| Concepts and Objectives - AM Unique Capabilities - Part Consolidation - Topology Optimization - Lightweight Structures - DFAM for Part Quality Improvement - CAD Modeling - Model Reconstruction - Data Processing for AM - Data Formats - Data Interfacing - Part Orientation - Support Structure Design and Support Structure Generation - Model Slicing - Tool Path Generation. Design Requirements of Additive Manufacturing: For Part Production, For Mass Production, For Series Production. Case Studies. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | DESIGNING FOR 3D PRINTING                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   | 9      |
| General design considerations for 3D printing, 3D printed features, Designing for Material Jetting, Binder Jetting, FFF, SLA/DLP, SLS, DMLS/SLM, design rules                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | DESIGN STANDARDS FOR ADDITIVE MANUFACTURING                                                                                                                                                                                                                                                                                                                                                                                                                              |          |   |   |   | 9      |
| Methods of testing and Testing organization - ASTM, ANSI, NBS, NEMA, NFPA, VL, SPI AND SPE.                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | "Design for Additive Manufacturing: Trends, Techniques, and Applications" by Amit Bandyopadhyay and Susmita Bose.                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | "Additive Manufacturing: Design, Methods, and Processes" by K. L. Johnson.                                                                                                                                                                                                                                                                                                                                                                                               |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Andreas Gebhardt and Jan-Steffen Hotter, “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications Munchen, Germany, 2015. ISBN: 978-1- 56990-582-1.                                                                                                                                                                                                                                                                                  |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Ben Redwood, Brian Garret, Filemon Schöffner, and Tony Fadel, “The 3D Printing Handbook: Technologies, Design and Applications”, 3DHubs B.V. Netherland, 2017. ISBN-13: 978-9082748505.                                                                                                                                                                                                                                                                                  |          |   |   |   |        |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Ian Gibson, David W. Rosen and Brent Stucker, “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing” Springer - New York, USA, 2nd Edition, 2015. ISBN-13: 978-1493921126.                                                                                                                                                                                                                                                             |          |   |   |   |        |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototyping development”, CRC Press, 1st Edition, 2007 FL, USA. ISBN- 9780849334092.                                                                                                                                                                                                                                                                                          |          |   |   |   |        |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                                                                                             |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                          | Recognize the importance in the evolution of SFM/AM, proliferation into the various fields and its effects on supply chain. |     |     |     |     |     |     |     |     |      |      | Understanding                |      |      |
| CO2:                                                                          | Evaluate the design for AM and its importance in the quality of fabricated parts                                            |     |     |     |     |     |     |     |     |      |      | Evaluating                   |      |      |
| CO3:                                                                          | Acquire knowledge on principles and applications of polymerization and sheet lamination processes with case studies.        |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO4:                                                                          | Acquire knowledge on principles of material extrusion and powder bed fusion processes and design guidelines.                |     |     |     |     |     |     |     |     |      |      | Understanding                |      |      |
| CO5:                                                                          | Perceive jetting and direct energy deposition processes and their applications.                                             |     |     |     |     |     |     |     |     |      |      | Understanding                |      |      |
| Mapping of COs with POs and PSOs                                              |                                                                                                                             |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/Pos                                                                       | PO1                                                                                                                         | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                           | 1                                                                                                                           | 1   | 1   | 2   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                           | 3                                                                                                                           | 1   | 3   | 3   | 3   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                           | 3                                                                                                                           | 3   | 2   | 3   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                           | 2                                                                                                                           | 2   | 2   | 3   | 3   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                           | 3                                                                                                                           | 1   | 3   | 3   | 3   | 3   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                          | 2.4                                                                                                                         | 1.6 | 2.2 | 2.8 | 2.6 | 1.4 | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial BT – Bloom’s Taxonomy               |                                                                                                                             |     |     |     |     |     |     |     |     |      |      |                              |      |      |

|                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |   |   |   |        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|---|--------|
| PPDE2410                                                                                                                                                                                                                                                                                                            | QUALITY AND FINANCIAL CONCEPTS IN PRODUCT DEVELOPMENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | PCC      | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                     | <ul style="list-style-type: none"><li>Applying the concept and principles of quality tools such as seven old and new tools of quality, SPC, multivariate charts, box plots, Pareto charts in product development.</li><li>Applying the concept and principles of quality tools such as benchmarking, QFD, HoQ, and reliability in product development.</li><li>Applying the concept and principles of Six Sigma and Lean manufacturing in product development.</li><li>Applying the concept and principles of robust design and embodiment design in product development.</li><li>Applying the concept and principles of finance and working capital management in product development.</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                            | QUALITY TOOLS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   | 9      |
| Seven Statistical Tools of Quality – New Seven Management Tools – Multivariable Charts and 3D Plot – Statistical Process Control: Problems in Mean and Range Chart; p, np, u and c chart; Problems in Box Plot and Pareto Chart.                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                           | QUALITY TOOLS II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |   |   |   | 9      |
| Benchmarking: Types; Process; Benefits – Quality Function Deployment (QFD): Concept; Benefits; Process; House of Quality: Structure and Methodology – Reliability: Hazard / Failure Rate; Mean Time Between Failure; Simple problems in Series; Parallel; Combination; Standby Systems.                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                          | DESIGN FOR SIXSIGMA AND LEAN PRINCIPLES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   | 9      |
| Six Sigma: Definition; Concept ;Process (DMAIC Methodology) – Project selection for Six Sigma (Types of Quality Problems) – Key Tools in Lean Production / Manufacturing – 4R Total Improvement – PDSA Cycle: Phases; Benefits – Kaizen and Kairyo – 5S House Keeping – TPM: Definition; Objective; Pillars; Steps. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                           | ROBUST DESIGN AND EMBODIMENT DESIGN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |   |   |   | 9      |
| Robust Design: Definition; Process Steps – Embodiment Design: Basic methods: Refining geometry and layout – General process of product embodiment – Embodiment checklist – Advanced methods: Systems modeling – Mechanical embodiment principles – FMEA Procedure; benefits.                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                            | FINANCE AND WORKING CAPITAL MANAGEMENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   | 9      |
| Financial Planning: Definition; Need; Sources; Capital Structure; Capitalization; Term Loans; Short term Finance; Venture Capital; Export Finance – Working Capital Management: Definition; Significance; Assessment; Factors; Sources; Management.                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                  | "Product Design and Development" by Karl T. Ulrich and Steven D. Eppinger                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                  | "Total Quality Management: Key Concepts and Case Studies" by D.R. Kiran                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                  | Fundamentals of Quality control and improvement 2nd edition, AMITAVA MITRA, Pearson Education Asia, 2002.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                  | . Product Design and Development, KARL T. ULRICH, STEVEN D. EPPINGER, TATA McGraw-HILL- 3rd Editions, 2003.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |

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|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3. | Product Design Techniques in Reverse Engineering and New Product Development, KEVIN OTTO & KRISTIN WOOD, Pearson Education (LPE), 2001.                                                                           |
| 4. | The Management and control of Quality-6th edition-James R. Evens, William M Lindsay Pub: son south-western University of Mumbai, Mechanical Engineering, M E Product Design and Development (New 2014) Page 8/48. |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                                                                                                                                          |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                          | Apply the concept and principles of quality tools such as seven old and new tools of quality, SPC, multivariate charts, box plots, Pareto charts in product development. |     |     |     |     |     |     |     |     |      |      | Analysing                    |      |      |
| CO2:                                                                          | Apply the concept and principles of quality tools such as benchmarking, QFD, HoQ, and reliability in product development.                                                |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO3:                                                                          | Apply the concept and principles of Six Sigma and Lean manufacturing in product development.                                                                             |     |     |     |     |     |     |     |     |      |      | Analysing                    |      |      |
| CO4:                                                                          | Apply the concept and principles of robust design and embodiment design in product development.                                                                          |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| CO5:                                                                          | Apply the concept and principles of finance and working capital management in product development.                                                                       |     |     |     |     |     |     |     |     |      |      | Analysing                    |      |      |
| Mapping of COs with POs and PSOs                                              |                                                                                                                                                                          |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/Pos                                                                       | PO1                                                                                                                                                                      | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                           | 2                                                                                                                                                                        | 2   | 2   | 2   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                           | 2                                                                                                                                                                        | 2   | 2   | 2   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                           | 2                                                                                                                                                                        | 2   | 2   | 2   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                           | 2                                                                                                                                                                        | 2   | 2   | 2   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                           | 2                                                                                                                                                                        | 2   | 2   | 2   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                          | 2                                                                                                                                                                        | 2   | 2   | 2   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial BT – Bloom’s Taxonomy               |                                                                                                                                                                          |     |     |     |     |     |     |     |     |      |      |                              |      |      |

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| PPDE2411                                                                                                                                                                                                                                                                                                                                                                                 | OPTIMIZATION TECHNIQUES IN DESIGN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | PCC      | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                          | <ul style="list-style-type: none"><li>To understand the basic concepts of unconstrained optimization techniques.</li><li>To understand the basic concepts of constrained optimization techniques.</li><li>To provide the mathematical foundation of artificial neural networks and swarm intelligence for design problems.</li><li>To implement optimization approaches and to select appropriate solution for design application.</li><li>To demonstrate selected optimization algorithms commonly used in static and dynamic applications</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                                                 | UNCONSTRAINED OPTIMIZATION TECHNIQUES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |   |   |   | 9      |
| Introduction to optimum design - General principles of optimization – Problem formulation & their classifications- Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, Random, pattern and gradient search methods – Interpolation methods.                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                                                | CONSTRAINED OPTIMIZATION TECHNIQUES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |   |   |   | 9      |
| Optimization with equality and inequality constraints-Direct methods-Indirect methods using penalty functions, Lagrange multipliers-Geometric programming.                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                                               | ARTIFICIAL NEURAL NETWORKS AND SWARM INTELLIGENCE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   | 9      |
| Introduction-Activation functions, types of activation functions, neural network architectures, Single layer feed forward network, multi layer feed forward network, Neural network applications. Swarm intelligence-Variants of animal behaviors, Ant Colony optimization, Particle Swarm optimization.                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                                                | ADVANCED OPTIMIZATION TECHNIQUES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |          |   |   |   | 9      |
| Multistage optimization-dynamic programming, stochastic programming Multi objective optimization Genetic algorithms and Simulated Annealing technique.                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                                                 | STATIC AND DYNAMIC APPLICATIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   | 9      |
| Structural applications – Design of simple truss members – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members – Design of springs. Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms-Optimum design of simple linkage mechanisms. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                       | "Engineering Optimization: Theory and Practice" by Singiresu S. Rao.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                       | "Optimization in Engineering Design" by Kalyanmoy Deb.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                       | Goldberg, David.E, “Genetic Algorithms in Search,Optimization and MachineLearning”,Pearson,2009.                                                                                                                                                                                                                                                                                                                                                                                                                                                      |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                       | Jang, J.S.R,Sun, C.TandMizutaniE., "Neuro-Fuzzy and Soft Computing",PearsonEducation.2015,                                                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| 3.                                                                                                                                                                                                                                                                                                                                                                                       | JohnsonRay,C.,“Optimumdesignofmechanicalelements”,Wiley,2ndEdition1980                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   |        |
| 4.                                                                                                                                                                                                                                                                                                                                                                                       | KalyanmoyDeb,“OptimizationforEngineeringDesign:AlgorithmsandExamples”,PHILearningPrivateLimited,2nd Edition,2012.                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
| 6.                                                                                                                                                                                                                                                                                                                                                                                       | Rajasekaran S and Vijayalakshmi Pai, G.A,"Neural Networks,FuzzyLogic and Genetic Algorithms", PHI, 2011.                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |   |   |   |        |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                                                    |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                          | Formulate unconstrained optimization techniques in engineering design application. |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| CO2:                                                                          | Formulate constrained optimization techniques for various applications.            |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| CO3:                                                                          | Implement neural network technique to real world design problems.                  |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO4:                                                                          | 4 Apply genetic algorithms to combinatorial optimization problems.                 |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO5:                                                                          | Evaluate solutions by various optimization approaches for a design problem.        |     |     |     |     |     |     |     |     |      |      | Evaluating                   |      |      |
| Mapping of COs with POs and PSOs                                              |                                                                                    |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/Pos                                                                       | PO1                                                                                | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                           | 3                                                                                  | 3   | 2   | -   | -   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                           | 3                                                                                  | 2   | 2   | -   | 2   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                           | 3                                                                                  | 2   | 3   | -   | 2   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                           | 3                                                                                  | 3   | 3   | -   | 2   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                           | 3                                                                                  | 3   | 3   | 3   | 2   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                          | 3                                                                                  | 2.6 | 2.6 | 3   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial BT – Bloom’s Taxonomy               |                                                                                    |     |     |     |     |     |     |     |     |      |      |                              |      |      |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
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| PPDE2412                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | VIBRATION ANALYSIS AND CONTROL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | PCC      | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"><li>• To appreciate the basic concepts of vibration in damped and undamped systems</li><li>• To calculate the natural frequencies and mode shapes of the two degree freedom systems</li><li>• To determine the natural frequencies and mode shapes of the multi degree freedom and continuous systems</li><li>• To learn the fundamentals of control techniques of vibration and noise levels</li><li>• To use the instruments for the measuring and analyzing the vibration levels in a body</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | FUNDAMENTALS OF VIBRATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |   |   |   | 9      |
| Introduction -Sources of Vibration-Mathematical Models- Displacement, velocity and Acceleration Review Of Single Degree Freedom Systems -Vibration isolation Vibrometers and accelerometers - Response To Arbitrary and non-harmonic Excitations – Transient Vibration –Impulse loads Critical Speed Of Shaft-Rotor systems.                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | TWO DEGREE FREEDOM SYSTEM                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |   |   |   | 9      |
| Introduction-Free Vibration Of Undamped And Damped - Forced Vibration With Harmonic Excitation System – Coordinate Couplings And Principal Coordinates.                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | MULTI-DEGREE FREEDOM SYSTEM AND CONTINUOUS SYSTEM                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   | 9      |
| Multi Degree Freedom System –Influence Coefficients and stiffness coefficients- Flexibility Matrix and Stiffness Matrix – Eigen Values and Eigen Vectors-Matrix Iteration Method –Approximate Methods: Dunkerley, Rayleigh’s, and Holzer Method -Geared Systems-Eigen Values & Eigenvectors for large system of equations using sub space, Lanczos method - Continuous System: Vibration of String, Shafts and Beams                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | VIBRATION AND NOISE CONTROL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |   |   |   | 9      |
| Specification of Vibration Limits – Vibration severity standards- Vibration as condition Monitoring Tool-Vibration Isolation methods - Dynamic Vibration Absorber - Static and Dynamic Balancing machines – Field balancing - Major sources of noise – Noise survey techniques – Measurement technique for vehicular noise – Road vehicle noise standards – Industrial noise sources – Control Strategies – Noise control at the source and along the path – use of acoustic barriers – Noise control at the receiver. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | EXPERIMENTAL METHODS IN VIBRATION ANALYSIS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   | 9      |
| Vibration Analysis Overview - Experimental Methods in Vibration Analysis.-Vibration Measuring Instruments - Selection of Sensors- Accelerometer Mountings. -Vibration Exciters-Mechanical, Hydraulic, Electromagnetic And Electrodynamics –Frequency Measuring Instruments-. System Identification from Frequency Response -Testing for resonance and mode shapes                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | "Mechanical Vibrations" by Singiresu S. Rao.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | "Vibration and Acoustics: Measurement and Signal Analysis" by Richard H. Rand.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Graham Kelly, Sand Shashidhar K. Kudari, “Mechanical Vibrations”, Tata McGraw – Hill Publishing Com. Ltd., 2007                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Singiresu S. Rao,”Mechanical Vibrations,”Pearson Education Incorporated, 2017                                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |   |   |   |        |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Ramamurti.V,“MechanicalVibrationPracticewithBasicTheory”,NarosaPublishingHouse, 2010                                                                                                                                                                                                                                                                                                                                                                                                                                                      |          |   |   |   |        |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                                                                      |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                          | Apply the basic concepts of vibration in damped and undamped systems.                                |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO2:                                                                          | Determine the natural frequencies and mode shapes of the two degree freedom systems.                 |     |     |     |     |     |     |     |     |      |      | Analyzing                    |      |      |
| CO3:                                                                          | Calculate the natural frequencies and mode shapes of the multi degree freedom and continuous systems |     |     |     |     |     |     |     |     |      |      | Analyzing                    |      |      |
| CO4:                                                                          | Control the vibration and noise levels in a body.                                                    |     |     |     |     |     |     |     |     |      |      | Evaluating                   |      |      |
| CO5:                                                                          | Measure and analyze the vibration levels in a body.                                                  |     |     |     |     |     |     |     |     |      |      | Analyzing                    |      |      |
| Mapping of COs with POs and PSOs                                              |                                                                                                      |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/Pos                                                                       | PO1                                                                                                  | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                           | 3                                                                                                    | 3   | 2   | -   | -   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                           | 3                                                                                                    | 2   | 2   | -   | 2   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                           | 3                                                                                                    | 2   | 3   | -   | 2   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                           | 3                                                                                                    | 3   | 3   | -   | 2   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                           | 3                                                                                                    | 3   | 3   | 3   | 2   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                          | 3                                                                                                    | 2.6 | 2.6 | 3   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial BT – Bloom’s Taxonomy               |                                                                                                      |     |     |     |     |     |     |     |     |      |      |                              |      |      |

| PPDE2413                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                       | IOT TECHNOLOGIES                                                                                                                                                                                                                                                                                                                                         |   |   |   |        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|--------|
|                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                       | Category                                                                                                                                                                                                                                                                                                                                                 | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                       | PCC                                                                                                                                                                                                                                                                                                                                                      | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                       | <ul style="list-style-type: none"><li>To understand the different architectures for IoT.</li><li>To learn various protocols at the different layers for IoT.</li><li>To develop prototype systems using Arduino RaspberryPi.</li><li>To apply the use of data analytics in IoT.</li><li>To develop applications of IoT in Industrial contexts.</li></ul> |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                       | ARCHITECTURES AND MODELS                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                          |   |   |   | 9      |
| Introduction to IoT – IoT Architectures – Core IoT Functional Stack, Sensors and Actuators Layer, Communications Network Layer, Applications and Analytics Layer – IoT Data Management and Compute Stack, Fog Computing, Edge Computing, Cloud Computing – Sensors, Actuators, Smart Objects, Sensor networks. |                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                      | CONNECTIVITY                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                          |   |   |   | 9      |
| Communications Criteria – Access Technologies – IP as IoT Network Layer – Business case – Optimization – Profiles and compliances – Application Protocols – Transport Layer – Application Transport Methods                                                                                                    |                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                     | SYSTEM DEVELOPMENT                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                          |   |   |   | 9      |
| Design Methodology – Case study – Basic blocks of IoT device – Raspberry Pi – Board, Interfaces, Linux, Setting up, Programming – Arduino – Other IoT Devices.                                                                                                                                                 |                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                      | DATA ANALYTICS AND IoT SECURITY                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                          |   |   |   | 9      |
| Data Analytics for IoT – Big Data Analytics Tools and Technology – Edge Streaming Analytics – Network Analytics, Applications. Security history, challenges, variations – Risk Analysis Structures– Application in Operational Environment.                                                                    |                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                       | IoT IN INDUSTRY                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                          |   |   |   | 9      |
| Manufacturing, Architecture, Protocols – Utilities, Grid Blocks - Smart Cities, Architecture, Use cases – Transportation, Architecture, Use cases                                                                                                                                                              |                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                             | "Internet of Things: A Hands-On Approach" by Arshdeep Bahga and Vijay Madiseti.                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                             | "Internet of Things: Principles and Paradigms" edited by Rajkumar Buyya, Amir Vahid Dastjerdi                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                             | 1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things”, Cisco Press, 2017                    |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                             | Olivier Hersent, David Boswarthick, Omar Elloum, “The Internet of Things – Key applications and Protocols”, Wiley, 2012.                                                                                              |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
| 3.                                                                                                                                                                                                                                                                                                             | Michael Miller, “The Internet of Things”, Pearson Education, 2015.                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
| 4.                                                                                                                                                                                                                                                                                                             | Arshdeep Bahga, Vijay Madiseti, “Internet of Things–A hands-on approach”, Universities Press, 2015.                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
| 5.                                                                                                                                                                                                                                                                                                             | Jan Ho" ller, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things-Introduction to a New Age of Intelligence", Elsevier, 2014. |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
| 6.                                                                                                                                                                                                                                                                                                             | Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.                                                                                                   |                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                                               |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                          | Explain the underlying architectures and models in IoT.                       |     |     |     |     |     |     |     |     |      |      | Understanding                |      |      |
| CO2:                                                                          | Analyze different connectivity technologies for IoT.                          |     |     |     |     |     |     |     |     |      |      | Analyzing                    |      |      |
| CO3:                                                                          | Develop simple applications using Arduino/RaspberryPi.                        |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| CO4:                                                                          | Apply data analytics techniques to IoT.                                       |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO5:                                                                          | Study the need and suggest appropriate solutions for Industrial applications. |     |     |     |     |     |     |     |     |      |      | Evaluating                   |      |      |
| Mapping of COs with POs and PSOs                                              |                                                                               |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/Pos                                                                       | PO1                                                                           | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                           | 1                                                                             | 1   | 1   | 2   | 1   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                           | 1                                                                             | 1   | 1   | 2   | 1   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                           | 1                                                                             | 1   | 1   | 2   | 1   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                           | 1                                                                             | 1   | 1   | 2   | 1   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                           | 1                                                                             | 1   | 1   | 2   | 1   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                          | 1                                                                             | 1   | 1   | 2   | 1   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial BT – Bloom’s Taxonomy               |                                                                               |     |     |     |     |     |     |     |     |      |      |                              |      |      |

|                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|--------|
| PPDE2414                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                        | COMPUTATIONAL FLUID DYNAMICS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                        | Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                        | PCC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                        | <ul style="list-style-type: none"><li>• This course aims to introduce numerical modeling and its role in the field of heat, fluid flow and combustion. It will enable the students to understand the various discretisation methods and solving methodologies and to create confidence to solve complex problems in the field of heat transfer and fluid dynamics.</li><li>• To develop finite volume discretised forms of the governing equations for diffusion processes.</li><li>• To develop finite volume discretised forms of the convection-diffusion processes.</li><li>• To develop pressure-based algorithms for flow processes.</li><li>• To introduce various turbulence models, Large Eddy Simulation and Direct Numerical Simulation..</li></ul> |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                        | GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |   |   | 9      |
| Basics of Heat Transfer, Fluid flow – Mathematical description of fluid flow and heat transfer – Conservation of mass, momentum, energy and chemical species - Classification of partial differential equations – Initial and Boundary Conditions – Discretisation techniques using finite difference methods – Taylor’s Series - Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test. |                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                        | DIFFUSION PROCESSES: FINITE VOLUME METHOD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |   |   | 9      |
| Steady one-dimensional diffusion, Two- and three-dimensional steady state diffusion problems, Discretisation of unsteady diffusion problems – Explicit, Implicit and Crank-Nicholson’s schemes, Stability of schemes.                                                                                                                                                                                      |                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                        | CONVECTION-DIFFUSION PROCESSES: FINITE VOLUME METHOD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |   |   | 9      |
| One dimensional convection – diffusion problem, Central difference scheme, upwind scheme – Hybrid and power law discretization techniques – QUICK scheme.                                                                                                                                                                                                                                                  |                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                        | FLOW PROCESSES: FINITE VOLUME METHOD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |   |   | 9      |
| Discretisation of incompressible flow equations – Pressure based algorithms, SIMPLE, SIMPLER & PISO algorithms.                                                                                                                                                                                                                                                                                            |                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                        | TURBULENCE MODELS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |   |   | 9      |
| Turbulence – RANS equation - Algebraic Models, One equation model, Two equation models – k & standard k – $\epsilon$ model, Low Reynold number models of k- $\epsilon$ , Large Eddy Simulation (LES), Direct Numerical Simulation (DNS) - Introduction. Solving simple cases using standard CFD codes.                                                                                                     |                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                         | "Computational Fluid Dynamics: The Basics with Applications" by John D. Anderson                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                         | "Introduction to Computational Fluid Dynamics: Development, Application, and Analysis" by Atul Sharma. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |

| <b>REFERENCES:</b> |                                                                                                                                                                   |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.                 | Versteeg and Malalasekera, N, “An Introduction to computational Fluid Dynamics The Finite Volume Method,” Pearson Education, Ltd., Second Edition, 2014.          |
| 2.                 | Ghoshdastidar, P.S., “Computer Simulation of Flow and Heat Transfer”, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998.                               |
| 3.                 | Muralidhar, K., and Sundararajan, T., “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi, 2003.                                     |
| 4.                 | Subas and V.Patankar “Numerical heat transfer fluid flow”, Hemisphere Publishing Corporation, 1980.                                                               |
| 5.                 | JiyuanTu, Guan Heng Yeoh, Chaogun Liu, “Computational Fluid Dynamics A Practical Approach” Butterworth – Heinemann An Imprint of Elsevier, Madison, U.S.A., 2008. |
| 6.                 | John D. Anderson. JR. “Computational Fluid Dynamics the Basics with Applications” McGraw-Hill International Editions, 1995.                                       |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                                                            |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                          | Analyse the governing equations and boundary conditions.                                   |     |     |     |     |     |     |     |     |      |      | Analysing                    |      |      |
| CO2:                                                                          | Analyse various discretization techniques for both steady and unsteady diffusion problems. |     |     |     |     |     |     |     |     |      |      | Analysing                    |      |      |
| CO3:                                                                          | Analyse the various convection-diffusion problems by Finite-Volume method.                 |     |     |     |     |     |     |     |     |      |      | Analysing                    |      |      |
| CO4:                                                                          | Analyse the flow processes by using different pressure bound algorithms.                   |     |     |     |     |     |     |     |     |      |      | Analysing                    |      |      |
| CO5:                                                                          | Select and use the different turbulence models according to the type of flows.             |     |     |     |     |     |     |     |     |      |      | Evaluating                   |      |      |
| Mapping of COs with POs and PSOs                                              |                                                                                            |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/Pos                                                                       | PO1                                                                                        | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                           | 2                                                                                          | 1   | 1   | 3   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                           | 2                                                                                          | 1   | 1   | 3   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                           | 3                                                                                          | 1   | 1   | 3   | 3   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                           | 3                                                                                          | 1   | 1   | 3   | 3   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                           | 3                                                                                          | 1   | 1   | 3   | 3   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                          | 2.6                                                                                        | 1   | 3   | -   | 3   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial BT – Bloom’s Taxonomy               |                                                                                            |     |     |     |     |     |     |     |     |      |      |                              |      |      |

|                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
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| PPDE2415                                                                                                                                                                             | HUMAN FACTORS ENGINEERING IN PRODUCT DESIGN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
|                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Category | L | T | P | Credit |
|                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | PCC      | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                      | <ul style="list-style-type: none"><li>Applying the fundamental concepts and principles of ergonomics in product design and development.</li><li>Applying the concept and principles of work place design in product design and development.</li><li>Applying the concept and principles of equipment design in product design and development.</li><li>Applying the concept and principles of environmental design in product design and development.</li><li>Applying the concept and principles of cognitive ergonomics &amp; human factor application in product design and development.</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                             | FUNDAMENTALS OF ANTHROPOMETRYIN ERGONOMICS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   | 9      |
| Anthropometry and its uses in ergonomics – Principles of applied anthropometry in ergonomics – Application of anthropometry in design – Design for everyone.                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| UNIT – II                                                                                                                                                                            | ERGONOMICS IN WORKPLACE DESIGN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   | 9      |
| Design for standing workers – Design for seated workers – Design for repetitive task – Design for manual handling activity task – Design for work capacity, stress, and fatigue      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| UNIT – III                                                                                                                                                                           | ERGONOMICS INEQUIPMENTDESIGN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   | 9      |
| Design for visual displays – Design for auditory displays – Design for controls – Design for virtual environments.                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                            | ERGONOMICS INENVIRONMENTAL DESIGN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   | 9      |
| Heat, cold and the design of the physical environment – Vision, light and lighting – Hearing, sound, noise and vibration                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
|                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| UNIT – V                                                                                                                                                                             | COGNITIVE ERGONOMICS & HUMANFACTORAPPLICATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   | 9      |
| Human information processing, skill and performance – Human–computer interaction, memory and language – Human–machine interaction, human error and safety. Resonance and mode shapes |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| 1.                                                                                                                                                                                   | "Human Factors Engineering and Ergonomics: A Systems Approach" by K. Michael Carayon                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |   |   |   |        |
| 2.                                                                                                                                                                                   | "The Design of Everyday Things" by Don Norman                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| 1.                                                                                                                                                                                   | Bridger R S, “Introduction to Ergonomics”, Taylor and Francis, London,2003.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
| 2.                                                                                                                                                                                   | Chandler Allen Phillips, “Human Factors Engineering”, John Wiley and sons, New York, 2000.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| 3.                                                                                                                                                                                   | Mark S Sanders, “Human Factors in Engineering and Design”, McGraw Hill, New York, 1993.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |   |   |   |        |
| 4.                                                                                                                                                                                   | Martin Helander, “A guide to Human Factors and Ergonomics”, 2nd Edition, CRC, Taylor & Francis Group 2006.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| 5.                                                                                                                                                                                   | McCormik, J., “Human Factors Engineering and Design”, McGraw Hill,1992.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |   |   |   |        |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                                                                                        |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |          |      |  |
|-------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|----------|------|--|
| CO1:                                                                          | Apply the fundamental concepts and principles of ergonomics in product design and.                                     |     |     |     |     |     |     |     |     |      |      |                              | Applying |      |  |
| CO2:                                                                          | Apply the concept and principles of work place design in product design and development.                               |     |     |     |     |     |     |     |     |      |      |                              | Applying |      |  |
| CO3:                                                                          | Apply the concept and principles of equipment design in product design and development.                                |     |     |     |     |     |     |     |     |      |      |                              | Applying |      |  |
| CO4:                                                                          | Apply the concept and principles of environmental design in product design and development                             |     |     |     |     |     |     |     |     |      |      |                              | Applying |      |  |
| CO5:                                                                          | Apply the concept and principles of cognitive ergonomics & human factor application in product design and development. |     |     |     |     |     |     |     |     |      |      |                              | Applying |      |  |
| Mapping of COs with POs and PSOs                                              |                                                                                                                        |     |     |     |     |     |     |     |     |      |      |                              |          |      |  |
| COs/Pos                                                                       | PO1                                                                                                                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1     | PSO2 |  |
| CO1                                                                           | 2                                                                                                                      | 2   | 2   | 3   | 2   | 2   | -   | -   | -   | -    | -    | -                            | -        | -    |  |
| CO2                                                                           | 2                                                                                                                      | 2   | 2   | 3   | 2   | 2   | -   | -   | -   | -    | -    | -                            | -        | -    |  |
| CO3                                                                           |                                                                                                                        | 2   | 2   | 3   | 2   | 2   | -   | -   | -   | -    | -    | -                            | -        | -    |  |
| CO4                                                                           | 2                                                                                                                      | 2   | 2   | 3   | 2   | 2   | -   | -   | -   | -    | -    | -                            | -        | -    |  |
| CO5                                                                           | 2                                                                                                                      | 2   | 2   | 3   | 2   | 2   | -   | -   | -   | -    | -    | -                            | -        | -    |  |
| Avg.                                                                          | 2                                                                                                                      | 2   | 2   | 3   | 2   | 2   | -   | -   | -   | -    | -    | -                            | -        | -    |  |
| 1 – Slight, 2 – Moderate, 3 – Substantial BT – Bloom’s Taxonomy               |                                                                                                                        |     |     |     |     |     |     |     |     |      |      |                              |          |      |  |

|                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
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| PPDE2416                                                                                                                                                                                                                                                                                                                                        | DESIGN OF HYBRID AND ELECTRIC VEHICLES                                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                            | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                            | PCC      | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                 | <ul style="list-style-type: none"><li>Fundamental concepts of electric and hybrid vehicle operation and architectures.</li><li>Understand the properties of batteries and its types.</li><li>Provide knowledge about design of series hybrid electric vehicles.</li><li>Provide knowledge about design of parallel hybrid electric vehicles.</li><li>Understand of electric vehicle drive train.</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                        | INTRODUCTION TO ELECTRIC VEHICLES                                                                                                                                                                                                                                                                                                                                                                          |          |   |   |   | 9      |
| Electric Vehicles (EV) system- EV History – EV advantages – EV market – vehicle mechanics: roadway fundamentals-law of motion-vehicle kinetics- dynamics of vehicle motion – propulsion power–velocity and acceleration-propulsion system design.                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                       | ENERGY SOURCE                                                                                                                                                                                                                                                                                                                                                                                              |          |   |   |   | 9      |
| Battery basics-lead acid battery–alternative batteries–battery parameters-technical characteristics– battery power–alternative energy sources: Fuel cells-Fuel Cell characteristics-Fuel cell types.                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                      | SERIES HYBRID ELECTRIC DRIVE TRAIN DESIGN                                                                                                                                                                                                                                                                                                                                                                  |          |   |   |   | 9      |
| Operation Patterns- Control Strategies-Sizing of the Major Components -Design of peaking power source-Traction Motor Size - Design of the Gear Ratio-Verification of Acceleration Performance- .Verification of grade ability-- Design of Engine/Generator Size - Design of the Power Capacity-Design of the Energy Capacity –Fuel Consumption. |                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                       | PARALLEL HYBRID ELECTRIC DRIVE TRAIN DESIGN                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   | 9      |
| Control Strategies of ParallelHybridDriveTrain-DriveTrainParameters-EnginePowerCapacity- Electric Motor Drive Power Capacity-Transmission Design- Energy Storage Design                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                        | ELECTRIC VEHICLE DRIVE TRAIN                                                                                                                                                                                                                                                                                                                                                                               |          |   |   |   | 9      |
| EV Transmission configurations–Transmission components–Ideal gear box–Gearratio-torque–speed characteristics-EV motor sizing–initial acceleration-rated vehicle velocity–maximum velocity – maximum gradability                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                              | "Electric Vehicle Technology Explained" by James Larminie and John Lowry                                                                                                                                                                                                                                                                                                                                   |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                              | "Hybrid Electric Vehicles: Principles and Applications" by Chris Mi, M. Abul Masrur, and David W. Gao                                                                                                                                                                                                                                                                                                      |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                              | Ehsani,M, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press,2005                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                              | “Hybrid Electric Vehicle Technology Assessment: Methodology, Analytical Issues, and Interim Results,”CenterforTransportationResearchArgonneNationalLaboratory,United States Department of Energy.                                                                                                                                                                                                          |          |   |   |   |        |
| 3.                                                                                                                                                                                                                                                                                                                                              | Iqbal Hussain, “Electric & Hybrid Vehicles– Design Fundamentals”, Second Edition, CRC Press,2011.                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| 4.                                                                                                                                                                                                                                                                                                                                              | James Larminie, “Electric Vehicle Technology Explained”, John Wiley & Sons, 2003.                                                                                                                                                                                                                                                                                                                          |          |   |   |   |        |
| 5.                                                                                                                                                                                                                                                                                                                                              | Sandeep Dhameja, “Electric Vehicle Battery Systems”, Newnes, 2000 .http://nptel.ac.in/courses/108103009/                                                                                                                                                                                                                                                                                                   |          |   |   |   |        |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                                                         |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                          | Explain how a hybrid vehicle works and describe its main components and their function. |     |     |     |     |     |     |     |     |      |      | Understanding                |      |      |
| CO2:                                                                          | Choose proper energy storage systems for vehicle applications                           |     |     |     |     |     |     |     |     |      |      | Evaluating                   |      |      |
| CO3:                                                                          | Design series hybrid electric vehicles.                                                 |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| CO4:                                                                          | Design parallel hybrid electric vehicles.                                               |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| CO5:                                                                          | Describe the transmission components and their configurations for electric vehicles     |     |     |     |     |     |     |     |     |      |      | Understanding                |      |      |
| Mapping of COs with POs and PSOs                                              |                                                                                         |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/Pos                                                                       | PO1                                                                                     | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                           | 2                                                                                       | 1   | 3   | 2   | 2   | 3   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                           | 2                                                                                       | 1   | 3   | 2   | 2   | 3   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                           | 2                                                                                       | 1   | 3   | 2   | 2   | 3   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                           | 2                                                                                       | 1   | 3   | 2   | 2   | 3   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                           | 2                                                                                       | 1   | 3   | 2   | 2   | 3   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                          | 2                                                                                       | 1   | 3   | 2   | 2   | 3   | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial BT – Bloom’s Taxonomy               |                                                                                         |     |     |     |     |     |     |     |     |      |      |                              |      |      |

| PPDE2417                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                 | ROTOR DYNAMICS                                                                                                                                                                                                                                                                                                                                                                    |   |   |   |        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|--------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                 | Category                                                                                                                                                                                                                                                                                                                                                                          | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                 | PCC                                                                                                                                                                                                                                                                                                                                                                               | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                 | <ul style="list-style-type: none"><li>• Apply and develop mathematical model of a system</li><li>• Applying the design and suggest bearings for specific applications</li><li>• Applying a fatigue life calculation for various types of bearings</li><li>• Apply and analyze bearing behavior</li><li>• Study the dynamics of rotors mounted on Hydrodynamic Bearings.</li></ul> |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | INTRODUCTION TO ROTOR DYNAMICS                                                  |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   | 9      |
| Torsional vibrations analysis – critical speeds and response to imbalance- Transfer matrix analysis- Instability of rotors- Gyroscopic effects                                                                                                                                                                                                                                                                                                                                          |                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | HYDRODYNAMIC BEARINGS                                                           |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   | 9      |
| Hydrodynamic Lubrication equation for dynamic loadings-Squeeze film effects in journal bearings and thrust bearings - Rotating loads , alternating and impulse loads in journal bearings – Journal center Trajectory- Analysis of short bearings under dynamic conditions- Finite difference solution for dynamic conditions.                                                                                                                                                           |                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | BALANCING OF ROTORS                                                             |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   | 9      |
| Classification of rotors and balancing criteria, balancing of rigid and flexible rotors- balance criteria for flexible rotors.                                                                                                                                                                                                                                                                                                                                                          |                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ROTOR DYNAMICS IN TURBOMACHINEY DESIGN                                          |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   | 9      |
| Motion of the shaft in the bearing- Rotor supported on rigid and flexible supports-Campbell diagram, Rotor Dynamic Analyses- Undamped critical speed - Unbalance response- Damped eigenvalue analysis- Bearing stiffness and damping coefficients- Mechanics of Hydro dynamic Instability- Half frequency whirl and Resonance whip- bearing instability and Oil Whirl Technologies to Improve the Stability of Rotor-bearing Systems--Design configurations of stable journal bearings. |                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | DYNAMICS OF ROTORS MOUNTED ON HYDRODYNAMIC BEARINGS                             |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   | 9      |
| Hydrodynamic Lubrication equation for dynamic loadings-Squeeze film effects in journal bearings and thrust bearings -Rotating loads , alternating and impulse loads in journal bearings – Journal center Trajectory- Analysis of short bearings under dynamic conditions- Finite difference solution for dynamic conditions.                                                                                                                                                            |                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | "Rotordynamics of Turbomachinery" by William W. Peng and John M. Vance          |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | "Principles of Rotational Dynamics" by David A. Hall                            |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | . Ehrich(ed.), F.F., 1992, Handbook of Rotor dynamics, McGraw-Hill.             |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Genta, G., 1999, Vibration of Structures and Machines, 3rd edition, Springer    |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Genta, G., 2005, Dynamics of Rotating Systems, Springer, NY                     |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Goodwin M.J., 1989, Dynamics of Rotor-Bearing Systems, Unwin Hyman, Sydney.     |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
| 5.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Krämer E., 1993, Dynamics of Rotors and Foundations, Springer-Verlag, New York. |                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                                                    |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                          | Understand application of various types of bearings and their operating principles |     |     |     |     |     |     |     |     |      |      | Understanding                |      |      |
| CO2:                                                                          | Design and suggest bearings for specific applications                              |     |     |     |     |     |     |     |     |      |      | Creating                     |      |      |
| CO3:                                                                          | Perform fatigue life calculations for various types of bearings,                   |     |     |     |     |     |     |     |     |      |      | Analyzing                    |      |      |
| CO4:                                                                          | Understand and analyze bearing behavior                                            |     |     |     |     |     |     |     |     |      |      | Analyzing                    |      |      |
| CO5:                                                                          | Study the dynamics of rotors mounted on Hydrodynamic Bearings                      |     |     |     |     |     |     |     |     |      |      | Analyzing                    |      |      |
| Mapping of COs with POs and PSOs                                              |                                                                                    |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/Pos                                                                       | PO1                                                                                | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                           | 3                                                                                  | 3   | 3   | -   | -   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                           | 3                                                                                  | 2   | 2   | -   | 2   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                           | 3                                                                                  | 2   | 2   | -   | 2   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                           | 3                                                                                  | 3   | 3   | -   | 2   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                           | 3                                                                                  | 3   | 3   | 3   | 2   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                          | 3                                                                                  | 2.6 | 2.2 | 3   | 2   | 1   | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial BT – Bloom’s Taxonomy               |                                                                                    |     |     |     |     |     |     |     |     |      |      |                              |      |      |

|                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|---|--------|
| PPDE2418                                                                                                                                                                                                                                                                                                                                                                                                                        | BIO MATERIALS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | PCC      | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                 | <ul style="list-style-type: none"><li>To study different concepts in selecting bio and smart materials</li><li>To import knowledge on different electro-rheological and piezoelectric materials</li><li>To import knowledge on different shape memory materials and their applications of materials in biomedical engineering and special materials for actuators, sensors, etc.</li><li>To import knowledge on Materials for oral and maxillofacial surgery</li><li>To import knowledge on materials for cardiovascular ophthalmology and skin regeneration.</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                                                                                        | INTRODUCTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   | 9      |
| Human anatomy- tissues- organs- repair- regeneration- Wolff’s Law – biomaterial – compatibility – classification - Biomimetics – Material response: swelling and leaching, corrosion and dissolution, deformation and failure, friction and wear – host response: the inflammatory process – coagulation and hemolysis- in vitro and in vivo evaluation of biomaterials – Testing and validation- government regulatory bodies. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                                                                                       | DENTAL MATERIALS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   | 9      |
| Teeth composition, formation and properties – temporary fixation devices - classification – biomaterials used- metals and alloys - Fillings and restoration materials – oral and maxillofacial surgery – dental cements and dental amalgams – dental adhesives.                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                                                                                      | ORTHOPAEDIC MATERIALS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |   |   |   | 9      |
| Bone composition, formation and regeneration - properties – defects - temporary fixation devices – joint replacement – biomaterials used in bone and joint replacement metals and alloys- stress shielding effect- bone tissue engineering.                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                                                                                       | WOUND DRESSING MATERIALS AND SURGICAL AIDS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |   |   |   | 9      |
| Skin structure – defects ( burn, ulcer, trauma etc) and disease- skin regeneration – classification of regenerative material – Sutures- Adhesives – classification – Surgical tools- materials – sterilization - Laparoscopic tools                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                                                                                        | CARDIOVASCULAR, OPHTHALMOLOGY AND DRUG DELIVERY MATERIALS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |   |   |   | 9      |
| Blood clotting – blood rheology– approaches to thrombo resistance materials development– blood vessels – The heart – aorta and valves – geometry of blood circulation – cardiac pacemakers – extracorporeal blood circulation devices. lungs – vascular implants: vascular graft, cardiac valve prostheses – Eye- defects – correction- Biomaterials in ophthalmology – drug delivery methods and materials.                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                              | "Biomaterials: An Introduction" by Joon Park and Rhonda S. Lakes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                              | "Biomaterials Science: An Introduction to Materials in Medicine" by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, and Jack E. Lemons.                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                              | M. V. Gandhi and B. S. Thompson, “Smart Materials and Structures”, Chapman and Hall, London, First Edition, 1992.                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                              | Sujata V., Bhat., “Biomaterials”, Narosa Publication House, New Delhi, 2002.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   |        |

|    |                                                                                                                                                                                                         |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3. | Buddy D. Ratner (Editor), Allan S. Hoffman (Editor), Frederick J. Schoen (Editor), Jack E. Lemons, "Biomaterials Science: An Introduction to Materials in Medicine", Academic Press, 2nd edition, 2004. |
| 4. | Duerig, T. W., Melton, K. N., Stockel, D. and Wayman, C.M., "Engineering aspects of Shape Memory Alloys", Butterworth – Heinemann, 1990.                                                                |
| 5. | Mohsen Shahinpoor and Hans-Joerg Schneider "Intelligent Materials", RSC Publishing, 2008.                                                                                                               |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                                             |     |     |     |     |     |     |     |     |      |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------------------------------|------|------|
| CO1:                                                                          | Use of Bio materials for cardiovascular Ophthalmology and Skin Regeneration |     |     |     |     |     |     |     |     |      |      |      | Applying                     |      |      |
| CO2:                                                                          | Use of Bio materials for Dental & Bone application                          |     |     |     |     |     |     |     |     |      |      |      | Applying                     |      |      |
| CO3:                                                                          | Use of shape memory alloys in engineering application                       |     |     |     |     |     |     |     |     |      |      |      | Applying                     |      |      |
| CO4:                                                                          | Explain the characteristics of Bio and smart materials                      |     |     |     |     |     |     |     |     |      |      |      | Understanding                |      |      |
| CO5:                                                                          | Use of smart materials as sensors, actuators.                               |     |     |     |     |     |     |     |     |      |      |      | Applying                     |      |      |
|                                                                               | Mapping of COs with POs and PSOs                                            |     |     |     |     |     |     |     |     |      |      |      |                              |      |      |
| COs/Pos                                                                       | PO1                                                                         | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1                         | PSO2 | PSO3 |
| CO1                                                                           | 2                                                                           | -   | -   | 3   | -   | -   | -   | -   | -   | -    | -    | -    | 1                            | -    |      |
| CO2                                                                           | 3                                                                           | 1   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -    | 1    |
| CO3                                                                           | 3                                                                           | -   | 1   | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2                            | -    |      |
| CO4                                                                           | 3                                                                           | 1   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -    | 2    |
| CO5                                                                           | 3                                                                           | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -    | 1    |
| Avg.                                                                          | 2.8                                                                         | 1   | 1   | 3   | -   | -   | -   | -   | -   | -    | -    | -    | 1.5                          | -    | 1.33 |
|                                                                               | 1 – Slight, 2 – Moderate, 3 – Substantial BT – Bloom’s Taxonomy             |     |     |     |     |     |     |     |     |      |      |      |                              |      |      |

| PAXCC2401                                                                                                                                                                                                                                                         |                                                                                                            | ENGLISH FOR RESEARCH PAPER WRITING                                                                                                                                                                                                                                                                                                                             |   |   |   |        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|--------|
|                                                                                                                                                                                                                                                                   |                                                                                                            | Category                                                                                                                                                                                                                                                                                                                                                       | L | T | P | Credit |
|                                                                                                                                                                                                                                                                   |                                                                                                            | AC                                                                                                                                                                                                                                                                                                                                                             | 2 | 0 | 0 | 0      |
| Course objectives                                                                                                                                                                                                                                                 |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
|                                                                                                                                                                                                                                                                   |                                                                                                            | <ul style="list-style-type: none"><li>• Teach how to improve writing skills and level of readability</li><li>• Tell about what to write in each section</li><li>• Summarize the skills needed when writing a Title</li><li>• Infer the skills needed when writing the Conclusion</li><li>• Ensure the quality of paper at very first-time submission</li></ul> |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                          |                                                                                                            | INTRODUCTION TO RESEARCH PAPER WRITING                                                                                                                                                                                                                                                                                                                         |   |   |   | 6      |
| Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.                                                                                  |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
|                                                                                                                                                                                                                                                                   |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                         |                                                                                                            | PRESENTATION SKILLS                                                                                                                                                                                                                                                                                                                                            |   |   |   | 6      |
| Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction                                                                                                           |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
|                                                                                                                                                                                                                                                                   |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                        |                                                                                                            | TITLE WRITING SKILLS                                                                                                                                                                                                                                                                                                                                           |   |   |   | 6      |
| Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
|                                                                                                                                                                                                                                                                   |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                         |                                                                                                            | RESULT WRITING SKILLS                                                                                                                                                                                                                                                                                                                                          |   |   |   | 6      |
| Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions                                                                                 |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
|                                                                                                                                                                                                                                                                   |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                          |                                                                                                            | VERIFICATION SKILLS                                                                                                                                                                                                                                                                                                                                            |   |   |   | 6      |
| Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission                                                                                                                                            |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
|                                                                                                                                                                                                                                                                   |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| Total: 30 periods                                                                                                                                                                                                                                                 |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                                                        |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                | Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011 |                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                | Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006                         |                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                       |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                | Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006                     |                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                | Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman’s book 1998.                   |                                                                                                                                                                                                                                                                                                                                                                |   |   |   |        |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                                             |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                          | Understand that how to improve your writing skills and level of readability |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO2:                                                                          | Learn about what to write in each section                                   |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO3:                                                                          | Understand the skills needed when writing a Title                           |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO4:                                                                          | Understand the skills needed when writing the Conclusion                    |     |     |     |     |     |     |     |     |      |      | understanding                |      |      |
| CO5:                                                                          | Ensure the good quality of paper at very first-time submission.             |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| Mapping of COs with POs and PSOs                                              |                                                                             |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/POs                                                                       | PO1                                                                         | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                           | 1                                                                           | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                           | 1                                                                           | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                           | 1                                                                           | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                           | 1                                                                           | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                           | 1                                                                           | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                          | 1                                                                           | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial , BT – Bloom’s Taxonomy             |                                                                             |     |     |     |     |     |     |     |     |      |      |                              |      |      |

|                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|---|--------|
| PAXCC2402                                                                                                                                                                                                                                                                                                                                           | DISASTER MANAGEMENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Category | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | AC       | 2 | 0 | 0 | 0      |
| Course objectives                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                     | <ul style="list-style-type: none"><li>Summarize basics of disaster</li><li>Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.</li><li>Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.</li><li>Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.</li><li>Develop the strengths and weaknesses of disaster management approaches</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                            | INTRODUCTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |          |   |   |   | 6      |
| Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                           | REPERCUSSIONS OF DISASTERS AND HAZARDS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |   |   |   | 6      |
| Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                          | DISASTER PRONE AREAS IN INDIA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |   |   |   | 6      |
| Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                           | DISASTER PREPAREDNESS AND MANAGEMENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |   |   |   | 6      |
| Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                            | RISK ASSESSMENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   | 6      |
| Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People’s Participation in Risk Assessment. Strategies for Survival                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| Total: 30 periods                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                  | Goel S. L., Disaster Administration And Management Text And Case Studies”,Deep & Deep Publication Pvt. Ltd., New Delhi,2009                                                                                                                                                                                                                                                                                                                                                                                                                             |          |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                  | NishithaRai, Singh AK, “Disaster Management in India: Perspectives, issues and strategies “New Royal book Company,2007.                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |   |   |   |        |
| 3.                                                                                                                                                                                                                                                                                                                                                  | Sahni, Pardeep Et.Al. ,” Disaster Mitigation Experiences And Reflections”, Prentice Hall Of India, New Delhi, 2001.                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |   |   |   |        |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                                                                                                                            |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                          | Ability to summarize basics of disaster.                                                                                                                   |     |     |     |     |     |     |     |     |      |      | Understanding                |      |      |
| CO2:                                                                          | Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.                                          |     |     |     |     |     |     |     |     |      |      | Analysing                    |      |      |
| CO3:                                                                          | Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.                                    |     |     |     |     |     |     |     |     |      |      | Analysing                    |      |      |
| CO4:                                                                          | Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations. |     |     |     |     |     |     |     |     |      |      | Applying                     |      |      |
| CO5:                                                                          | Ability to develop the strengths and weaknesses of disaster management approaches.                                                                         |     |     |     |     |     |     |     |     |      |      | Evaluating                   |      |      |
| Mapping of COs with POs and PSOs                                              |                                                                                                                                                            |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/POs                                                                       | PO1                                                                                                                                                        | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                           | 1                                                                                                                                                          | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                           | 1                                                                                                                                                          | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                           | 1                                                                                                                                                          | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                           | 1                                                                                                                                                          | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                           | 1                                                                                                                                                          | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                          | 1                                                                                                                                                          | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial , BT – Bloom’s Taxonomy             |                                                                                                                                                            |     |     |     |     |     |     |     |     |      |      |                              |      |      |

|                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |   |        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|--------|
| PAXCC2403                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                             | CONSTITUTION OF INDIA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                             | Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                             | AC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 2 | 0 | 0 | 0      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                             | <ul style="list-style-type: none"><li>Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.</li><li>To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.</li><li>To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.</li></ul> |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                             | HISTORY OF MAKING OF THE INDIAN CONSTITUTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |   |   | 5      |
| History, Drafting Committee, (Composition & Working)                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                             | PHILOSOPHY OF THE INDIAN CONSTITUTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |   |   | 5      |
| Preamble, Salient Features                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                             | CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |   |   | 5      |
| Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.                                                                                                                                                                                             |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                             | ORGANS OF GOVERNANCE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |   |   | 5      |
| Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.                                                                                                                                                                                                             |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                             | LOCAL ADMINISTRATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |   |   | 5      |
| District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy. |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |   |        |
| UNIT – VI                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                             | ELECTION COMMISSION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |   |   | 5      |
| Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.                                                                                                                                                                                                                                                                            |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |   |        |
| Total: 30 periods                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |   |        |
| REFERENCES:                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |   |        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                          | Goel S. L., Disaster Administration And Management Text And Case Studies”,Deep & Deep Publication Pvt. Ltd., New Delhi,2009 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |   |        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                          | NishithaRai, Singh AK, “Disaster Management in India: Perspectives, issues and strategies “”New Royal book Company,2007.    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |   |        |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                          | Sahni, Pardeep Et.Al. ,” Disaster Mitigation Experiences And Reflections”, Prentice Hall Of India, New Delhi, 2001.         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |   |        |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to |                                                                                                                                                                                                                                                   |     |     |     |     |     |     |     |     |      |      | BT Mapped<br>(Highest Level) |      |      |
|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------------------------------|------|------|
| CO1:                                                                          | Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.                                                                                                               |     |     |     |     |     |     |     |     |      |      | Analysing                    |      |      |
| CO2:                                                                          | Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.                                                                                               |     |     |     |     |     |     |     |     |      |      | Analysing                    |      |      |
| CO3:                                                                          | Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution |     |     |     |     |     |     |     |     |      |      | Evaluating                   |      |      |
| CO4:                                                                          | Discuss the passage of the Governance.                                                                                                                                                                                                            |     |     |     |     |     |     |     |     |      |      | Analysing                    |      |      |
| CO5:                                                                          | Discuss the passage of the Local Administration.                                                                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      | Analysing                    |      |      |
| CO6:                                                                          | Discuss the passage of the Hindu Code Bill of 1956.                                                                                                                                                                                               |     |     |     |     |     |     |     |     |      |      | Evaluating                   |      |      |
| Mapping of COs with POs and PSOs                                              |                                                                                                                                                                                                                                                   |     |     |     |     |     |     |     |     |      |      |                              |      |      |
| COs/POs                                                                       | PO1                                                                                                                                                                                                                                               | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12                         | PSO1 | PSO2 |
| CO1                                                                           | 1                                                                                                                                                                                                                                                 | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO2                                                                           | 1                                                                                                                                                                                                                                                 | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO3                                                                           | 1                                                                                                                                                                                                                                                 | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO4                                                                           | 1                                                                                                                                                                                                                                                 | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO5                                                                           | 1                                                                                                                                                                                                                                                 | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| CO6                                                                           | 1                                                                                                                                                                                                                                                 | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| Avg.                                                                          | 1                                                                                                                                                                                                                                                 | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -                            | -    | -    |
| 1 – Slight, 2 – Moderate, 3 – Substantial , BT – Bloom’s Taxonomy             |                                                                                                                                                                                                                                                   |     |     |     |     |     |     |     |     |      |      |                              |      |      |

|                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |   |   |   |        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---|---|---|--------|
| PAXCC2404                                                                                                                                                                                                        | நற்றமிழ் இலக்கியம்                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |   |   |   |        |
|                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Category | L | T | P | Credit |
|                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | AC       | 2 | 0 | 0 | 0      |
| Course objectives                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |   |   |   |        |
|                                                                                                                                                                                                                  | <ul style="list-style-type: none"><li>Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.</li><li>To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.</li><li>To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.</li></ul> |          |   |   |   |        |
| UNIT – I                                                                                                                                                                                                         | சங்க இலக்கியம்                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |   |   |   | 5      |
| 1. தமிழின் துவக்க நூல் தொல்காப்பியம்<br>– எழுத்து, சொல், பொருள்<br>2. அகநானூறு (82)<br>– இயற்கை இன்னிசை அரங்கம்<br>3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி<br>4. புறநானூறு (95,195)<br>– போரை நிறுத்திய ஔவையார்      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |   |   |   |        |
| UNIT – II                                                                                                                                                                                                        | அறநெறிதமிழ்                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |          |   |   |   | 5      |
| 1. அறநெறி வகுத்த திருவள்ளுவர்<br>– அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல், ஈகை, புகழ்<br>2. பிற அறநூல்கள் - இலக்கிய மருந்து<br>– ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல் ) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |   |   |   |        |
| UNIT – III                                                                                                                                                                                                       | இரட்டை காப்பியங்கள்                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |   |   |   | 5      |
| 1. கண்ணகியின் புரட்சி<br>– சிலப்பதிகார வழக்குரை காதை<br>2. சமூகசேவை இலக்கியம் மணிமேகலை<br>– சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                        | அருள் நெறித்தமிழ்                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |   |   |   | 5      |

1. சிறுபாணாற்றுப்படை
  - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஓளவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
  - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
  - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
  - சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு

|          |                      |   |
|----------|----------------------|---|
| UNIT – V | நவீன தமிழ் இலக்கியம் | 5 |
|----------|----------------------|---|

1. உரைநடைத் தமிழ்,
  - தமிழின் முதல் புதினம்,
  - தமிழின் முதல் சிறுகதை,
  - கட்டுரை இலக்கியம்,
  - பயண இலக்கியம்,
  - நாடகம்,
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

**Total: 30 periods**

**REFERENCES:**

**தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்**

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)  
- [www.tamilvu.org](http://www.tamilvu.org)
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)  
- <https://ta.wikipedia.org>
3. தர்மபுர ஆதீன வெளியீடு
4. வாழ்வியல் களஞ்சியம்  
- தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம்  
- தமிழ் வளர்ச்சித் துறை ([thamilvalarchithurai.com](http://thamilvalarchithurai.com))
6. அறிவியல் களஞ்சியம்  
- தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

**Mapping of COs with POs and PSOs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1     | 1   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2     | 1   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO3     | 1   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO4     | 1   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO5     | 1   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO6     | 1   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| Avg.    | 1   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

| PPOE2401                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  | VIBRATION AND NOISE CONTROL STRATEGIES                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |   |   |        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|--------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  | Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  | OCC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  | <ul style="list-style-type: none"><li>• To appreciate the basic concepts of vibration in damped and undamped systems</li><li>• To appreciate the basic concepts of noise, its effect on hearing and related terminology</li><li>• To use the instruments for measuring and analyzing the vibration levels in a body</li><li>• To use the instruments for measuring and analyzing the noise levels in a system</li><li>• To learn the standards of vibration and noise levels and their control techniques</li></ul> |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  | BASICS OF VIBRATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |   |   | 9      |
| Introduction – Sources and causes of Vibration-Mathematical Models – Displacement, velocity and Acceleration – Classification of vibration: free and forced vibration, undamped and damped vibration, linear and non-linear vibration – Single Degree Freedom Systems – Vibration isolation – Determination of natural frequencies                                                                                                                                                                                                                                                                                                                         |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  | BASICS OF NOISE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   | 9      |
| Introduction – Anatomy of human ear – Mechanism of hearing – Amplitude, frequency, wavelength and sound pressure level – Relationship between sound power, sound intensity and sound pressure level – Addition, subtraction and averaging decibel levels – sound spectra -Types of sound fields – Octave band analysis – Loudness.                                                                                                                                                                                                                                                                                                                         |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  | INSTRUMENTATION FOR VIBRATION MEASUREMENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |   |   | 9      |
| Experimental Methods in Vibration Analysis.- Vibration Measuring Instruments – Selection of Sensors – Accelerometer Mountings – Vibration Exciters – Mechanical, Hydraulic, Electromagnetic and Electrodynamics – Frequency Measuring Instruments -. System Identification from Frequency Response -Testing for resonance and mode shapes                                                                                                                                                                                                                                                                                                                  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  | INSTRUMENTATION FOR NOISE MEASUREMENT AND ANALYSIS                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |   |   | 9      |
| Microphones – Weighting networks – Sound Level meters, its classes and calibration – Noise measurements using sound level meters – Data Loggers – Sound exposure meters – Recording of noise – Spectrum analyser – Intensity meters – Energy density sensors – Sound source localization.                                                                                                                                                                                                                                                                                                                                                                  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  | METHODS OF VIBRATION CONTROL, SOURCES OF NOISE AND ITS CONTROL                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |   |   | 9      |
| Specification of Vibration Limits – Vibration severity standards – Vibration as condition Monitoring Tool – Case Studies – Vibration Isolation methods – Dynamic Vibration Absorber – Need for Balancing – Static and Dynamic Balancing machines – Field balancing – Major sources of noise – Noise survey techniques – Measurement technique for vehicular noise – Road vehicles Noise standard – Noise due to construction equipment and domestic appliances – Industrial noise sources and its strategies – Noise control at the source – Noise control along the path – Acoustic Barriers – Noise control at the receiver — Sound transmission through |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |

|                                                                   |                                                                                                                              |     |     |     |     |     |     |     |     |      |      |      |                              |                   |  |
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| barriers – Noise reduction Vs Transmission loss – Enclosures      |                                                                                                                              |     |     |     |     |     |     |     |     |      |      |      |                              |                   |  |
|                                                                   |                                                                                                                              |     |     |     |     |     |     |     |     |      |      |      |                              | Total: 45 periods |  |
| TEXT BOOK:                                                        |                                                                                                                              |     |     |     |     |     |     |     |     |      |      |      |                              |                   |  |
| 1.                                                                | "Singiresu S. Rao, “Mechanical Vibrations”, Pearson Education Incorporated, 2017.                                            |     |     |     |     |     |     |     |     |      |      |      |                              |                   |  |
| 2.                                                                | Graham Kelly. Sand Shashidhar K. Kudari, “Mechanical Vibrations”, Tata McGraw –Hill Publishing Com. Ltd., 2007.              |     |     |     |     |     |     |     |     |      |      |      |                              |                   |  |
| REFERENCES:                                                       |                                                                                                                              |     |     |     |     |     |     |     |     |      |      |      |                              |                   |  |
| 1.                                                                | Ramamurti. V, “Mechanical Vibration Practice with Basic Theory”, Narosa Publishing House, 2000.                              |     |     |     |     |     |     |     |     |      |      |      |                              |                   |  |
| 2.                                                                | . International Journal of Product Lifecycle Management, Inderscience Publishers                                             |     |     |     |     |     |     |     |     |      |      |      |                              |                   |  |
| 3.                                                                | William T. Thomson, “Theory of Vibration with Applications”, Taylor & Francis, 2003.                                         |     |     |     |     |     |     |     |     |      |      |      |                              |                   |  |
| 4.                                                                | G.K. Grover, “Mechanical Vibrations”, Nem Chand and Bros.,Roorkee, 2014.                                                     |     |     |     |     |     |     |     |     |      |      |      |                              |                   |  |
| 5.                                                                | A.G. Ambekar, “Mechanical Vibrations and Noise Engineering”, PHI Learning Pvt. Ltd., 2014.                                   |     |     |     |     |     |     |     |     |      |      |      |                              |                   |  |
| 6.                                                                | David A. Bies and Colin H. Hansen, “Engineering Noise Control – Theory and Practice”, Spon Press, London and New York, 2009. |     |     |     |     |     |     |     |     |      |      |      |                              |                   |  |
| COURSE OUTCOMES:<br>The students will be able to                  |                                                                                                                              |     |     |     |     |     |     |     |     |      |      |      | BT Mapped<br>(Highest Level) |                   |  |
| CO1:                                                              | Apply the basic concepts of vibration in damped and undamped systems                                                         |     |     |     |     |     |     |     |     |      |      |      |                              | Understanding     |  |
| CO2:                                                              | Apply the basic concepts of noise and to understand its effects on systems                                                   |     |     |     |     |     |     |     |     |      |      |      |                              | Applying          |  |
| CO3:                                                              | Select the instruments required for vibration measurement and its analysis                                                   |     |     |     |     |     |     |     |     |      |      |      |                              | Applying          |  |
| CO4:                                                              | Select the instruments required for noise measurement and its analysis.                                                      |     |     |     |     |     |     |     |     |      |      |      |                              | Analyzing         |  |
| CO5:                                                              | Recognize the noise sources and to control the vibration levels in a body and to control noise under different strategies.   |     |     |     |     |     |     |     |     |      |      |      |                              | Analyzing         |  |
| Mapping of COs with POs and PSOs                                  |                                                                                                                              |     |     |     |     |     |     |     |     |      |      |      |                              |                   |  |
| COs/POs                                                           | PO1                                                                                                                          | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1                         | PSO 2             |  |
| CO1                                                               | 1                                                                                                                            | 2   | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -                 |  |
| CO2                                                               | 2                                                                                                                            | 2   | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -                 |  |
| CO3                                                               | 2                                                                                                                            | 1   | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -                 |  |
| CO4                                                               | 1                                                                                                                            | 1   | 3   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -                 |  |
| CO5                                                               | 1                                                                                                                            | 1   | 1   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -                 |  |
| Avg.                                                              | 1.4                                                                                                                          | 1.4 | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -                 |  |
| 1 – Slight, 2 – Moderate, 3 – Substantial , BT – Bloom’s Taxonomy |                                                                                                                              |     |     |     |     |     |     |     |     |      |      |      |                              |                   |  |

| PPOE2402                                                                                                                                                                                                                      |                                                                                                                 | ENERGY CONSERVATION AND MANAGEMENT IN DOMESTIC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |   |   |        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|--------|
|                                                                                                                                                                                                                               |                                                                                                                 | Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | L | T | P | Credit |
|                                                                                                                                                                                                                               |                                                                                                                 | OCC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                             |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
|                                                                                                                                                                                                                               |                                                                                                                 | <ul style="list-style-type: none"><li>• To learn the present energy scenario and the need for energy conservation.</li><li>• To understand the different measures for energy conservation in utilities.</li><li>• Acquaint students with principle theories, materials, and construction techniques to create energy efficient buildings.</li><li>• To identify the energy demand and bridge the gap with suitable technology for sustainable habitat</li><li>• To get familiar with the energy technology, current status of research and find the ways to optimize a system as per the user requirement</li></ul> |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                      |                                                                                                                 | BENERGY SCENARIO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |   |   | 9      |
| Primary energy resources – Sectorial energy consumption (domestic, industrial and other sectors), Energy pricing, Energy conservation and its importance, Energy Conservation Act-2001 and its features – Energy star rating. |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
|                                                                                                                                                                                                                               |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                     |                                                                                                                 | HEATING, VENTILLATION & AIR CONDITIONING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |   |   | 9      |
| Basics of Refrigeration and Air Conditioning – COP / EER / SEC Evaluation – SPV system design & optimization for Solar Refrigeration.                                                                                         |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
|                                                                                                                                                                                                                               |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                    |                                                                                                                 | LIGHTING, COMPUTER, TV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |   |   | 9      |
| Specification of Luminaries – Types – Efficacy – Selection & Application – Time Sensors – Occupancy Sensors – Energy conservation measures in computer – Television – Electronic devices.                                     |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
|                                                                                                                                                                                                                               |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                     |                                                                                                                 | ENERGY EFFICIENT BUILDINGS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |   |   | 9      |
| Conventional versus Energy efficient buildings – Landscape design – Envelope heat loss and heat gain – Passive cooling and heating – Renewable sources integration.                                                           |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
|                                                                                                                                                                                                                               |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                      |                                                                                                                 | ENERGY STORAGE TECHNOLOGIES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |   |   | 9      |
| Necessity & types of energy storage – Thermal energy storage – Battery energy storage, charging and discharging– Hydrogen energy storage & Super capacitors – energy density and safety issues – Applications..               |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                             |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
| TEXT BOOK:                                                                                                                                                                                                                    |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
| 1.                                                                                                                                                                                                                            | "Singiresu S. Rao, “Mechanical Vibrations”, Pearson Education Incorporated, 2017.                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |
| 2.                                                                                                                                                                                                                            | Graham Kelly. Sand Shashidhar K. Kudari, “Mechanical Vibrations”, Tata McGraw –Hill Publishing Com. Ltd., 2007. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   |        |

| REFERENCES:                                                       |                                                                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
|-------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------------------------------|---------------|--|
| 1.                                                                | Yogi Goswami, Frank Kreith, Energy Efficiency and Renewable energy Handbook, CRC Press, 2016                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
| 2.                                                                | ASHRAE Handbook 2020 – HVAC Systems & Equipment                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
| 3.                                                                | Paolo Bertoldi, Andrea Ricci, Anibal de Almeida, Energy Efficiency in Household Appliances and Lighting, Conference proceedings, Springer, 2001                                                        |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
| 4.                                                                | David A. Bainbridge, Ken Haggard, Kenneth L. Haggard, Passive Solar Architecture: Heating, Cooling Ventilation, Daylighting, and More Using Natural Flows, Chelsea Green Publishing, 2011.             |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
| 5.                                                                | Guide book for National Certification Examination for Energy Managers and Energy Auditors (Could be downloaded from <a href="http://www.energymanagertraining.com">www.energymanagertraining.com</a> ) |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
| 6.                                                                | Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.                                                                                             |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
| COURSE OUTCOMES:<br>The students will be able to                  |                                                                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      | BT Mapped<br>(Highest Level) |               |  |
| CO1:                                                              | Understand technical aspects of energy conservation scenario.                                                                                                                                          |     |     |     |     |     |     |     |     |      |      |      |                              | Understanding |  |
| CO2:                                                              | Energy audit in any type for domestic buildings and suggest the conservation measures.                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |                              | Applying      |  |
| CO3:                                                              | Perform building load estimates and design the energy efficient landscape system.                                                                                                                      |     |     |     |     |     |     |     |     |      |      |      |                              | Applying      |  |
| CO4:                                                              | Gain knowledge to utilize an appliance/device sustainably.                                                                                                                                             |     |     |     |     |     |     |     |     |      |      |      |                              | Analyzing     |  |
| CO5:                                                              | Understand the status and current technological advancement in energy storage field.                                                                                                                   |     |     |     |     |     |     |     |     |      |      |      |                              | Analyzing     |  |
| Mapping of COs with POs and PSOs                                  |                                                                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
| COs/POs                                                           | PO1                                                                                                                                                                                                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1                         | PSO2          |  |
| CO1                                                               | 1                                                                                                                                                                                                      | 2   | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -             |  |
| CO2                                                               | 2                                                                                                                                                                                                      | 2   | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -             |  |
| CO3                                                               | 2                                                                                                                                                                                                      | 1   | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -             |  |
| CO4                                                               | 1                                                                                                                                                                                                      | 1   | 3   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -             |  |
| CO5                                                               | 1                                                                                                                                                                                                      | 1   | 1   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -             |  |
| Avg.                                                              | 1.4                                                                                                                                                                                                    | 1.4 | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -             |  |
| 1 – Slight, 2 – Moderate, 3 – Substantial , BT – Bloom’s Taxonomy |                                                                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |

| PPOE2403                                                                                                                                                                                                                                                                                                                                                                                                                      |  | ADDITIVE MANUFACTURING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |   |   |        |   |
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|                                                                                                                                                                                                                                                                                                                                                                                                                               |  | Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | L | T | P | Credit |   |
|                                                                                                                                                                                                                                                                                                                                                                                                                               |  | OCC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 3 | 0 | 0 | 3      |   |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                                             |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |   |   |        |   |
|                                                                                                                                                                                                                                                                                                                                                                                                                               |  | <ul style="list-style-type: none"><li>Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.</li><li>Acquire knowledge on process vat polymerization and material extrusion processes and its applications.</li><li>Elaborate the process and applications of powder bed fusion and binder jetting.</li><li>Evaluate the advantages, limitations, applications of material jetting and directed energy deposition processes.</li><li>Acquire knowledge on sheet lamination and direct write technology.</li></ul> |   |   |   |        |   |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                                                                                      |  | INTRODUCTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |   |   |        | 9 |
| Overview – Need – Development of Additive Manufacturing (AM) Technology: Rapid PrototypingRapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain – ASTM/ISO 52900 Classification – Benefits – AM Unique Capabilities – AM File formats: STL, AMF Applications: Building Printing, Bio Printing, Food Printing, Electronics Printing, Automobile, Aerospace, Healthcare. Business Opportunities in AM. |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |   |   |        |   |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                                                                                     |  | VAT POLYMERIZATION AND MATERIAL EXTRUSION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |   |   |        | 9 |
| Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process – top down and bottom up approach – Advantages – Limitations – Applications. Digital Light Processing (DLP) -Process – Advantages – Applications. Material Extrusion: Fused Deposition Modeling (FDM) – Process-Materials -Applications and Limitations.                                                                                          |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |   |   |        |   |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                                                                                    |  | DESIGN FOR POLYMER AM                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |   |   |        | 9 |
| Anisotropy, Wall Thicknesses, Overhangs, Support Material, Accuracy, Tolerances, Layer Thickness, Resolution, Print Orientation, Warpage, over sintering, Hollowing Parts, Horizontal Bridges, Connections, Fill Style, holes, fillets, ribs, font sizes and small details.                                                                                                                                                   |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |   |   |        |   |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                                                                                     |  | MATERIAL JETTING AND DIRECTED ENERGY DEPOSITION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |   |   |        | 9 |
| Material Jetting: Multijet Modeling- Materials – Process – Benefits – Applications.Directed Energy Deposition: Laser Engineered Net Shaping (LENS) – Process – Material Delivery -Materials -Benefits -Applications.                                                                                                                                                                                                          |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |   |   |        |   |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                                                                                      |  | SHEET LAMINATION AND DIRECT WRITE TECHNOLOGY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |   |   |        | 9 |
| Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding – Materials – Application and Limitation. Ink-Based Direct Writing (DW): Nozzle Dispensing Processes, Inkjet Printing Processes, Aerosol DW – Applications of DW.                                                                                                                            |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |   |   |        |   |

|                                                                   |                                                                                                                                   |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
|-------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------------------------------|---------------|--|
| Total: 45 periods                                                 |                                                                                                                                   |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
| TEXT BOOK:                                                        |                                                                                                                                   |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
| 1.                                                                | A Practical Guide to Design for Additive Manufacturing, Diegel, Olaf, Axel Nordin, and Damien Motte, Springer, 2020.              |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
| 2.                                                                | The 3D Printing Handbook: Technologies, Design and Applications, Redwood, Ben, Filemon Schoffer, and Brian Garret, 3D Hubs, 2017. |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
| REFERENCES:                                                       |                                                                                                                                   |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
| 1.                                                                | Design for Advanced Manufacturing: Technologies and Process, Laroux K, Gillespie, McGrawHill, 2017.                               |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
| 2.                                                                | Additive Manufacturing Technologies, Gibson, Ian, David W. Rosen, Brent Stucker, and Mahyar Khorasani, Springer, 2021.            |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
| 3.                                                                | Laser-Induced Materials and Processes for Rapid Prototyping, L.Lu, J. Y. H. Fuh and Y.S. Wong, Springer, 2001.                    |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
| 4.                                                                | Rapid Prototyping: Laser-based and Other Technologies, Patri K. Venuvinod and Weiyin Ma, Springer, 2004.                          |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
| 5.                                                                | A.G. Ambekar, “Mechanical Vibrations and Noise Engineering”, PHI Learning Pvt. Ltd., 2014.                                        |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
| 6.                                                                | Mathematical Elements for Computer Graphics, David F. Rogers, J. A. Adams, TMH,2008.                                              |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
| COURSE OUTCOMES:<br>The students will be able to                  |                                                                                                                                   |     |     |     |     |     |     |     |     |      |      |      | BT Mapped<br>(Highest Level) |               |  |
| CO1:                                                              | Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities. |     |     |     |     |     |     |     |     |      |      |      |                              | Understanding |  |
| CO2:                                                              | Acquire knowledge on process vat polymerization and material extrusion processes and its applications.                            |     |     |     |     |     |     |     |     |      |      |      |                              | Applying      |  |
| CO3:                                                              | Elaborate the process and applications of powder bed fusion and binder jetting.                                                   |     |     |     |     |     |     |     |     |      |      |      |                              | Applying      |  |
| CO4:                                                              | Evaluate the advantages, limitations, applications of material jetting and directed energy deposition processes.                  |     |     |     |     |     |     |     |     |      |      |      |                              | Analyzing     |  |
| CO5:                                                              | Acquire knowledge on sheet lamination and direct write technology.                                                                |     |     |     |     |     |     |     |     |      |      |      |                              | Analyzing     |  |
| Mapping of COs with POs and PSOs                                  |                                                                                                                                   |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |
| COs/POs                                                           | PO1                                                                                                                               | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1                         | PSO 2         |  |
| CO1                                                               | 1                                                                                                                                 | 2   | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -             |  |
| CO2                                                               | 2                                                                                                                                 | 2   | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -             |  |
| CO3                                                               | 2                                                                                                                                 | 1   | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -             |  |
| CO4                                                               | 1                                                                                                                                 | 1   | 3   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -             |  |
| CO5                                                               | 1                                                                                                                                 | 1   | 1   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -             |  |
| Avg.                                                              | 1.4                                                                                                                               | 1.4 | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                            | -             |  |
| 1 – Slight, 2 – Moderate, 3 – Substantial , BT – Bloom’s Taxonomy |                                                                                                                                   |     |     |     |     |     |     |     |     |      |      |      |                              |               |  |

| PPOE2404                                                                                                                                                                                                                                                                                                                                                                                                                                      |  | ELECTRIC VEHICLE TECHNOLOGY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |   |   |        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|--------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                               |  | Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                                                               |  | OCC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                                                             |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                               |  | <ul style="list-style-type: none"><li>Understand the fundamentals of different battery chemistries used in electric vehicles (lead-acid, nickel-based,lithium-ion).</li><li>Analyze electrochemical reactions, battery performance parameters, and thermodynamic concepts relevant to EV batteries.</li><li>Model battery systems using equivalent circuits and interpret charging/discharging characteristics.</li><li>Evaluate battery cooling, thermal management strategies, and safety considerations.</li><li>Compare and assess advanced energy storage systems such as ultracapacitors, flywheels, and fuel cells.</li></ul> |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                                                                                                      |  | NEED FOR ELECTRIC VEHICLES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |   |   | 9      |
| History and need for electric and hybrid vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies, comparison of diesel, petrol, electric and hybrid vehicles, limitations, technical challenges                                                                                                                                                                       |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                                                                                                     |  | ELECTRIC VEHICLE ARCHITECHTURE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |   |   | 9      |
| Electric vehicle types, layout and power delivery, performance – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, Concepts of hybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits and demerits, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles, Fuel cell vehicles. |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                                                                                                    |  | ENERGY STORAGE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |   |   |   | 9      |
| Batteries – types – lead acid batteries, nickel based batteries, and lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency, Battery modeling and equivalent circuit, battery charging and types, battery cooling, Ultracapacitors, Flywheel technology, Hydrogen fuel cell, Thermal Management of the PEM fuel cell                                                   |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                                                                                                     |  | ELECTRIC DRIVES AND CONTROL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |   |   | 9      |
| Types of electric motors – working principle of AC and DC motors, advantages and limitations, DC motor drives and control, Induction motor drives and control, PMSM and brushless DC motor -drives and control , AC and Switch reluctance motor drives and control – Drive system efficiency – Inverters – DC and AC motor speed controllers                                                                                                  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                                                                                                      |  | DESIGN OF ELECTRIC VEHICLES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |   |   | 9      |
| Materials and types of production, Chassis skate board design, motor sizing, power pack sizing, component matching, Ideal gear box – Gear ratio, torque–speed characteristics, Dynamic equation of vehicle motion,                                                                                                                                                                                                                            |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |   |   |        |

Maximum tractive effort – Power train tractive effort Acceleration performance, rated vehicle velocity – maximum gradability, Brake performance, Electronic control system, safety and challenges in electric vehicles. Case study of Nissan leaf, Toyota Prius, tesla model 3, and Renault Zoe cars.

**Total: 45 periods**

**TEXT BOOK:**

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition CRC Press, 2011.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

**REFERENCES:**

1. James Larminie, John Lowry, Electric Vehicle Technology Explained – Wiley, 2003.
2. Ehsani, M, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2005

**COURSE OUTCOMES:**

**The students will be able to**

**BT Mapped  
(Highest Level)**

|      |                                                                                                                                                     |               |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| CO1: | Students will be able to describe battery chemistries, cell structure, thermodynamic voltage, and EV-relevant electrochemical reactions.            | Understanding |
| CO2: | Students will calculate and interpret specific energy, specific power, coulombic efficiency, and state-of-charge (SoC).                             | Applying      |
| CO3: | Students will construct battery models and evaluate dynamic behavior under different load and temperature conditions.                               | Applying      |
| CO4: | Students will assess charging profiles (CC, CV, trickle, fast charging), cooling systems, and thermal management performance.                       | Analyzing     |
| CO5: | Students will select optimal storage systems (Li-ion, ultracapacitors, fuel cells, etc.) based on energy/power requirements and design constraints. | Analyzing     |

**Mapping of COs with POs and PSOs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1     | 1   | 2   | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2     | 2   | 2   | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO3     | 2   | 1   | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO4     | 1   | 1   | 3   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO5     | 1   | 1   | 1   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| Avg.    | 1.4 | 1.4 | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom’s Taxonomy

| PPOE2405                                                                                                                                                                                                                                                                                                                                                                                                           |  | NEW PRODUCT DEVELOPMENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |   |   |        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|--------|
|                                                                                                                                                                                                                                                                                                                                                                                                                    |  | Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | L | T | P | Credit |
|                                                                                                                                                                                                                                                                                                                                                                                                                    |  | OCC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 3 | 0 | 0 | 3      |
| Course objectives                                                                                                                                                                                                                                                                                                                                                                                                  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                    |  | <ul style="list-style-type: none"><li>Applying the principles of generic development process; and understanding the organization structure for new product design and development.</li><li>Identifying opportunity and planning for new product design and development.</li><li>Conducting customer need analysis; and setting product specification for new product design and development.</li><li>Generating, selecting, and testing the concepts for new product design and development.</li><li>Applying the principles of Industrial design and prototype for new product design and development.</li></ul> |   |   |   |        |
| UNIT – I                                                                                                                                                                                                                                                                                                                                                                                                           |  | INTRODUCTION TO PRODUCT DESIGN & DEVELOPMENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |   |   | 9      |
| Introduction – Characteristics of Successful Product Development – People involved in Product Design and Development – Duration and Cost of Product Development – The Challenges of Product Development – The Product Development Process – Concept Development: The Front End Process – Adapting the Generic Product Development Process – Product Development Process Flows – Product Development Organizations. |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
| UNIT – II                                                                                                                                                                                                                                                                                                                                                                                                          |  | OPPORTUNITY IDENTIFICATION & PRODUCT PLANNING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |   |   | 9      |
| Opportunity Identification: Definition – Types of Opportunities – Tournament Structure of Opportunity Identification – Effective Opportunity Tournaments – Opportunity Identification Process – Product Planning: Four types of Product Development Projects – The Process of Product Planning.                                                                                                                    |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
| UNIT – III                                                                                                                                                                                                                                                                                                                                                                                                         |  | IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |   |   | 9      |
| Identifying Customer Needs: The Importance of Latent Needs – The Process of Identifying Customer Needs. Product Specifications: Definition – Time of Specifications Establishment – Establishing Target Specifications – Setting the Final Specifications                                                                                                                                                          |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
| UNIT – IV                                                                                                                                                                                                                                                                                                                                                                                                          |  | CONCEPT GENERATION, SELECTION & TESTING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |   |   | 9      |
| Concept Generation: Activity of Concept Generation – Structured Approach – Five step method of Concept Generation. Concept Selection: Methodology – Concept Screening and Concepts Scoring. Concept testing: Seven Step activities of concept testing.                                                                                                                                                             |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
| UNIT – V                                                                                                                                                                                                                                                                                                                                                                                                           |  | INDUSTRIAL DESIGN & PROTOTYPING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   | 9      |
| Industrial Design: Need and Impact–Industrial Design Process. Prototyping – Principles of Prototyping – Prototyping Technologies – Planning for Prototypes.                                                                                                                                                                                                                                                        |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |
| Total: 45 periods                                                                                                                                                                                                                                                                                                                                                                                                  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |   |   |        |

|                                                                   |                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |                                      |               |  |
|-------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|--------------------------------------|---------------|--|
| <b>TEXT BOOK:</b>                                                 |                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |                                      |               |  |
| 1.                                                                | Ulrich K.T., Eppinger S. D. and Anita Goyal, “Product Design and Development “McGraw-Hill Education; 7 edition, 2020.                  |     |     |     |     |     |     |     |     |      |      |      |                                      |               |  |
| <b>REFERENCES:</b>                                                |                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |                                      |               |  |
| 1.                                                                | Belz A., 36-Hour Course: “Product Development” McGraw-Hill, 2010.                                                                      |     |     |     |     |     |     |     |     |      |      |      |                                      |               |  |
| 2.                                                                | Rosenthal S.,“Effective Product Design and Development”, Business One Orwin, Homewood, 1992,ISBN1-55623-603-4.                         |     |     |     |     |     |     |     |     |      |      |      |                                      |               |  |
| 3.                                                                | Pugh.S,“Total Design Integrated Methods for Successful Product Engineering”, Addison Wesley Publishing,1991,ISBN0-202-41639-5.         |     |     |     |     |     |     |     |     |      |      |      |                                      |               |  |
| 4.                                                                | Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.                                                 |     |     |     |     |     |     |     |     |      |      |      |                                      |               |  |
| 5.                                                                | Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.                                             |     |     |     |     |     |     |     |     |      |      |      |                                      |               |  |
| <b>COURSE OUTCOMES:</b><br>The students will be able to           |                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      | <b>BT Mapped<br/>(Highest Level)</b> |               |  |
| CO1:                                                              | Apply the principles of generic development process; and understand the organization structure for new product design and development. |     |     |     |     |     |     |     |     |      |      |      |                                      | Understanding |  |
| CO2:                                                              | Identify opportunity and plan for new product design and development.                                                                  |     |     |     |     |     |     |     |     |      |      |      |                                      | Applying      |  |
| CO3:                                                              | Conduct customer need analysis; and set product specification for new product design and development.                                  |     |     |     |     |     |     |     |     |      |      |      |                                      | Applying      |  |
| CO4:                                                              | Generate, select, and test the concepts for new product design and development.                                                        |     |     |     |     |     |     |     |     |      |      |      |                                      | Analyzing     |  |
| CO5:                                                              | Apply the principles of Industrial design and prototype for design and develop new products.                                           |     |     |     |     |     |     |     |     |      |      |      |                                      | Analyzing     |  |
| <b>Mapping of COs with POs and PSOs</b>                           |                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |                                      |               |  |
| COs/POs                                                           | PO1                                                                                                                                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1                                 | PSO<br>2      |  |
| CO1                                                               | 1                                                                                                                                      | 2   | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                                    | -             |  |
| CO2                                                               | 2                                                                                                                                      | 2   | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                                    | -             |  |
| CO3                                                               | 2                                                                                                                                      | 1   | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                                    | -             |  |
| CO4                                                               | 1                                                                                                                                      | 1   | 3   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                                    | -             |  |
| CO5                                                               | 1                                                                                                                                      | 1   | 1   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                                    | -             |  |
| Avg.                                                              | 1.4                                                                                                                                    | 1.4 | 2   | 1   | -   | -   | -   | -   | -   | -    | -    | -    | -                                    | -             |  |
| 1 – Slight, 2 – Moderate, 3 – Substantial , BT – Bloom’s Taxonomy |                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |                                      |               |  |



## THE KAVERY ENGINEERING COLLEGE

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