Register No : _____

# THE KAVERY ENGINEERING COLLEGE

*(An Autonomous Institution)*

B.E/B.TECH DEGREE END SEMESTER THEORY EXAMINATIONS, NOV/DEC 2025

*Third Semester*

*Mechanical Engineering*

ME3391 – Engineering Thermodynamics

(Common to Fourth Semester Agricultural Engineering)

(Steam Tables & Mollier Charts Can be Permitted)

*Regulations – 2021*

*Duration : 3 Hrs* *Maximum : 100 Marks*

*PART – A (ANSWER ALL QUESTIONS) (Marks 10*2=20)*

| *Q.No* | *Questions* | *BLT* | *CO* | *Marks* |
|---|---|---|---|---|
| 1. | State the First law of thermodynamics and limitations. | L2 | 1 | 2 |
| 2. | What is meant by thermodynamics system? How do you classify it? | L1 | 1 | 2 |
| 3. | Write the second law of thermodynamics. | L1 | 2 | 2 |
| 4. | State Carnot theorem and corollaries. | L2 | 2 | 2 |
| 5. | What do you understand by the entropy and entropy principle? | L1 | 3 | 2 |
| 6. | Define Availability and Irreversibility. | L1 | 3 | 2 |
| 7. | What is saturation temperature and saturation pressure? | L2 | 4 | 2 |
| 8. | Define triple point and critical point of pure substances. | L1 | 4 | 2 |
| 9. | Comparison between the ideal gas and real gas. | L2 | 5 | 2 |
| 10. | Define Helmholtz function and Gibbs function. | L2 | 5 | 2 |

*PART – B (ANSWER ALL QUESTIONS) (Marks 5*16 = 80)*

| *Q.No* | | *Questions* | *BLT* | *CO* | *Marks* |
|---|---|---|---|---|---|
| 11. | a | A fluid is confined in a cylinder by a spring-loaded, frictionless piston so that the pressure in the fluid is a linear function of the volume (p = a + bV). The internal energy of the fluid is given by the following equation U = 34 + 3.15pV where, U is KJ, p is in KPa, and V in $m^3$. If the fluid changes from an initial state of 170KPa, 0.03$m^3$ to a final state of 400KPa, 0.06$m^3$, with no work other than that done on the piston, Find the direction and magnitude of the work and heat transfer. | L3 | 1 | 16 |
| | | Or | | | |
| | b | A mass of air is initially at 260$^0$C and 700KPa and occupies 0.028$m^3$. The air is expanded at constant pressure to 0.084$m^3$. A polytropic process with n=1.5 is then carried out, followed by a constant temperature process. All the processes are reversible. (i) Sketch the cycle P-V and T-S planes (ii) Find the pressure, temperature and volume of all point, (iii) Find the heat received and heat rejected in the cycle (iv) work done (v) Find the efficiency of the cycle. | L3 | 1 | 16 |

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|---|---|---|---|---|---|---|
| 12. | a | | Two reversible heat engines A and B are arranged in series. A rejecting heat directly to B. engine A receives 200KJ at a temperature of $421^0$C. From a hot source, while engine B is to communication with a cold sink at a temperature of $4.4^0$C. If the work output of A is twice that of B. Find the i) Intermediate temperature between A and B. ii) Efficiency of each engine iii) Heat rejected to the cold sink. | L2 | 2 | 16 |
| | | | Or | | | |
| | b | i | Derive the efficiency of Carnot cycle and Explain with neat the help of P-V and T-S diagram. | L2 | 2 | 8 |
| | | ii | An inventor claims to have developed an engine which receives 1000KJ at a temperature of $160^0$C. It rejects heat at a temperature of $5^0$C and delivers 0.12KW/h of mechanical work. Is this valid claim? Justify your answer through Classius Inequality. | L2 | 2 | 8 |
| 13. | a | i | In certain heat exchanger 45KJ/min of water is to be heated from 60°C to 115°C by hot gases, which enter the heat exchanger 225°C and flows at the rate 90KJ/min. Compute the net change of entropy. Assume specific heat for water and gases as 4.18 KJ/Kg K and 1.045 KJ/Kg K. | L3 | 3 | 8 |
| | | ii | 3kg of air at 500Kpa, 90°C, expands adiabatically in a closed system until its volume is doubled and its temperature becomes equal to that of the surroundings at 100Kpa and 10°C. Find the maximum work and Irreversibility. | L3 | 3 | 8 |
| | | | Or | | | |
| | b | i | A block of iron weighing 100kg and having a temperature of 100°C is immersed in 50kg of water at a temperature of 20°C. what will be change of entropy of the combined system of iron and water? Specific heats of iron and water are 0.45KJ/K and 4.18KJ/K respectively. | L3 | 3 | 8 |
| | | ii | In a turbine the air expands from 7bar, 600°C to 1bar 250°C. during expansion 9KJ/Kg of heat as lost to the surroundings which is at 1bar, 15°C. Neglecting kinetic energy and potential energy changes, determine per Kg or air. (i) the decrease in availability (ii) the maximum work (iii) the Irreversibility (iv) second law efficiency, for air, take Cp=1.005KJ/Kg K, h=CpT, where Cp is constant. | L3 | 3 | 8 |
| 14. | a | i | Explain the process of formation of steam with the help of T-H diagram. | L2 | 4 | 8 |
| | | ii | A vessel of volume $0.04m^3$ contains a mixture of saturated water and steam at a temperature of 250°C. The mass of the liquid present is 9kg. Find the pressure, mass, specific volume, enthalpy, entropy and internal energy. | L2 | 4 | 8 |
| | | | Or | | | |
| | b | i | A rigid closed tank of volume $3m^3$ contains 5kg of wet steam at a pressure of 200KPa. The tank is heated until the steam becomes dry saturated. Determine the final pressure and the heat transfer to the tank. | L2 | 4 | 8 |
| | | ii | Steam enters an adiabatic turbine at 10Mpa and 500°C at the rate of 3kg/s and leaves at 50Kpa. If the Power output of turbine is 2MW. Determine the velocity of steam at exit of turbine. | L2 | 4 | 8 |

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| 15. | a | | A vessel is divided into three compartments (a), (b), and (c) by to partitions part(a) contains oxygen and has a volume of $0.1m^3$, (b) has a volume of $0.2m^3$ and contains nitrogen, while (c) is $0.05m^3$ and holds $CO_2$, all three parts are at a pressure of 2bar and a temperature of $13^oC$. When the partitions are removed and the gases mix, determine the change in entropy of each constituent, the final pressure in the vessel and the partial pressure of each gas. The vessel may be taken as being completely isolated from its surroundings. | L4 | 5 | 16 |
| | | | Or | | | |
| | b | i | Drive the Maxwell relations and explain their importance in thermodynamics. | L4 | 5 | 8 |
| | | ii | Explain and derive the clapeyron equation and state its assumptions. | L4 | 5 | 8 |