Register No : ________________

THE KAVERY ENGINEERING COLLEGE

(An Autonomous Institution)

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

Sixth Semester

Civil Engineering

CE3601 - Design of Steel Structural Elements

Use of IS 800-2007, IS 875-Part 3 and Steel Table is 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.	Classify the types of steel.	L2	1	2
2.	Define efficiency of a joint.	L1	1	2
3.	What is the shear lag effect?	L1	2	2
4.	State Euler's column theory.	L1	2	2
5.	Differentiate between laterally supported and unsupported beams.	L2	3	2
6.	Write a short note built-up beams.	L1	3	2
7.	Mention the types of loads act on trusses.	L1	4	2
8.	Recall the need of pre-engineered buildings.	L1	4	2
9.	Relate the theory of plastic analysis.	L2	5	2
10.	Infer the need of plastic design approach.	L2	5	2

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

Q.No		*Questions*	*BLT*	*CO*	*Marks*
11.	a	A 10 mm thick steel plate is connected to a support using bolted connections. The steel plate is subjected to a direct axial tensile force of 120 kN. The connection consists of 4 bolts, each with a diameter of 16 mm and a permissible shear stress of 100 MPa. Determine whether the bolts can safely carry the applied load without failing in shear. Consider the same steel plate connected to a support using 4 bolts in a rectangular pattern, each spaced 50 mm apart horizontally and vertically. An eccentric load of 80 kN is applied at an offset of 75 mm from the center of the bolt group. Calculate the maximum stress experienced by the bolts due to both direct and torsional loading.	L3	1	16
		Or			
	b	A steel angle bracket is used to connect a beam to a column using two bolts in tension, each with a diameter of 20 mm. Due to the applied load, prying action occurs at the connection, increasing the forces on the bolts and causing additional stress. A vertical load of 150 kN is applied at the free end of the bracket, which is located 300 mm from the bolts. Each bolt has a diameter of 20 mm and a permissible tensile stress of 200 MPa. The bracket properties are angle thickness = 10 mm; distance from bolt center to edge of bracket = 30 mm. The material properties are yield stress of the angle material = 250 MPa; young's modulus for steel, E = 210 GPa. Calculate the tensile force in each bolt due to the applied load and prying action.	L3	1	16

12.	a	A steel tension member is connected to a gusset plate using a lug angle to enhance load transfer. The tension member is subjected to a load of 250 kN. The yield stress of steel, fy = 250 MPa; ultimate tensile stress, fu = 410 MPa. Select an appropriate angle section for the given load and thickness of the lug angle = 10 mm; bolt diameter = 20 mm; permissible shear stress of bolt = 100 MPa; permissible bearing stress = 300 MPa; gusset Plate of thickness = 12 mm. Design the lug angle to safely transfer the applied load from the tension member to the gusset plate. Calculate the number of bolts required and their arrangement on the lug angle, considering shear, bearing, and block shear requirements.	L3	2	16
		Or			
	b	Design a concrete pedestal with a steel column base plate to support a 500 kN axial load from a steel column in a structural building. The column is an ISHB 300 section with a yield strength of 250 MPa. The column base is attached to a concrete pedestal (M25) and anchored with four bolts. The design should ensure safe load transfer from the column to the foundation. Steel yield stress, fy = 250 MPa; concrete grade = M25 with a permissible bearing stress of 5 MPa. Select the appropriate size and thickness for the base plate to safely transfer load to the concrete. Bolt diameter = 20 mm; yield stress of bolts = 250 MPa. Determine the dimensions of the base plate to ensure that the load is safely distributed to the concrete pedestal. Calculate the required thickness of the base plate based on bending strength criteria. Design the anchor bolts for safe transfer of loads, checking for bolt shear, tension, and bearing capacity.	L3	2	16
13.	a	Design a laterally unsupported steel beam to carry a uniformly distributed load over a span. The beam is part of an industrial structure, and lateral support is only provided at the ends. The beam supports a uniformly distributed load of 40 kN/m over a simply supported span of 8 m and yield strength of steel, fy = 250 MPa. Choose a suitable I-section for the beam from standard sections. The selected section must resist lateral-torsional buckling, shear, and bending. Consider lateral-torsional buckling for the beam, as it is unsupported along its span. Check the shear capacity of the selected section to ensure it can safely resist the applied shear force. Calculate the maximum deflection and verify that it is within permissible limits.	L4	3	16
		Or			
	b	A simply supported plate girder is required to carry a uniformly distributed load as part of a bridge structure. Design the plate girder, considering bending, shear, and deflection criteria, and ensure that the girder is stable under applied loading conditions. The girder supports a uniformly distributed load of 60 kN/m over a span of 20 meters, including self-weight. Yield strength of steel, fy = 250 MPa. Design the girder with a web depth-to-thickness ratio that ensures shear buckling resistance without the need for stiffeners. Maximum allowable width for flange plates is 300 mm. Assume that the web plate fabricated for a maximum height of 1800 mm. Determine the dimensions of the web and flange plates to resist the applied moment, considering bending strength requirements. Calculate the shear capacity of the web, considering the need for stiffeners if required. Check deflection under the applied load and ensure it is within permissible limits.	L4	3	16

14.	a	Design a purlin to support a roof system in an industrial building. The purlin spans between trusses and carries both the dead load of the roofing materials and live load due to wind. The purlin designed using either an angle or a channel section, based on load and deflection requirements. The purlin has a span of 4.5 meters. Dead load (including self-weight) = 0.6 kN/m; Live load due to wind = 0.8 kN/m; Steel yield strength, fy = 250 MPa; Modulus of Elasticity, E = 210 GPa. The purlin is simply supported at both ends. Design using a single-angle or channel section that satisfies strength and deflection criteria. Determine an appropriate angle or channel section that meets the bending and deflection requirements for the purlin. Calculate the maximum bending stress and compare it with the allowable bending stress.	L4	4	16
		Or			
	b	Design a gantry girder for an industrial workshop that supports an overhead crane. The gantry girder will carry both the crane's static and moving loads. The girder is simply supported between columns and design to ensure stability and safe load transfer to the supporting structure. The span of gantry girder as 7 meters between supports; Crane capacity = 200 kN; Self-weight of the crane = 50 kN; Crab (moving trolley) load = 50 kN. Maximum wheel load from the crane = 125 kN (including impact factor); Wheel spacing = 3 meters along the span of the gantry girder. The minimum edge distance from the nearest wheel load to the support = 1 meter; Steel yield strength, fy = 250 MPa; modulus of elasticity, E=210 GPa. Select an appropriate I-section or built-up section for the gantry girder that meets the bending strength requirements for both static and moving loads. Calculate the maximum bending moment and shear force, including the effect of the crane's moving load, and check against allowable values.	L4	4	16
15.	a	Design a continuous steel beam using the plastic design approach for a three-span beam in an industrial building. The beam is subjected to uniformly distributed loads on each span. Determine the section requirements and ensure the beam meets the criteria for plastic hinge formation and overall stability. The span length, middle span and right span of 5, 8 and 5 m respectively. Uniformly distributed dead load (including self-weight) = 15 kN/m on all spans; Uniformly distributed live load = 10 kN/m on all spans. Yield strength of steel, fy=250MPa; Modulus of Elasticity, E=210GPa.Assume full plasticity and design hinges will form at specific locations for collapse. Factor of safety for plastic design = 1.7.Determine the plastic moments (Mp) at each critical section (supports and mid-spans) needed for the beam to achieve collapse load under the applied loading. Calculate the collapse load by forming plastic hinges at key points along the beam, ensuring that the collapse mechanism is compatible with the spans.	L4	5	16
		Or			

b	Design a portal frame using the plastic design approach for an industrial warehouse. The frame will be subjected to wind loads and self-weight, and the design must ensure that it can safely withstand lateral and vertical loads while maintaining ductility and stability. The width of the frame (span) = 12 meters; height of the frame = 6 meters at the eaves; height of the frame = 9 meters at the ridge. Frame consists of two vertical columns and a horizontal beam (roof). Dead load (including self-weight) on the roof = 8 kN/m²; live load on the roof = 4 kN/m²; wind load = 1.5 kN/m² (acting horizontally on the frame). Yield strength of steel, fy = 250 MPa; Modulus of Elasticity, E = 210 GPa. Factor of safety for plastic design = 1.5. The frame is assumed to be symmetrical, bracing is not provided and ensure lateral stability through the design of plastic hinges. Determine the design loads for the portal frame, including total vertical and horizontal forces. Calculate the plastic moments (Mp) required at the beam and column sections based on the applied loads and the location of plastic hinges. Select appropriate I-sections for the columns and beam that meet the plastic moment requirements.	L4	5	16