Seat No./Enrollment No.: _____

GUJARAT TECHNOLOGICAL UNIVERSITY
BACHELOR OF ENGINEERING – SEMESTER 8 – EXAMINATION – SUMMER 2026

Subject Code: 2180610 **Date: 19/05/2026**

Subject Name: Design of Steel Structures

Time: 10:30 AM TO 01:30 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**
5. **Use of IS 800:2007, IS:875 and Steel table is permitted.**
6. **Consider $f_y = 250$ N/mm^2 and $f_u = 410$ N/mm^2 if not mention**

Q.1	**(a)**	Explain how wind loads on structural frames are determined as per IS:875 (Part 3), highlighting the influence of terrain category and topography.	**03**
	(b)	Enlist the main advantages and limitations of the Limit State Design philosophy over the Working Stress Design method for steel structures.	**04**
	(c)	A secondary beam section ISMB 300 is connected to the flange of a column section ISHB 200. Design a suitable bolted unstiffened seat connection to transfer a factored vertical shear reaction of 140 kN. Use Grade 4.6 bolts of 20 mm diameter.	**07**
Q.2	**(a)**	Distinguish between the elastic section modulus Ze and plastic section modulus Zp. Calculate the shape factor for a triangular cross-section of base b and height h.	**03**
	(b)	State the lower bound (static) and upper bound (kinematic) theorems of plastic collapse. Explain how a plastic hinge forms in a bending member.	**04**
	(c)	Determine the plastic moment capacity (Mp) and plastic shape factor for an asymmetric built-up I-section with the following dimensions: • Top Flange: 240 mm X 16 mm • Bottom Flange: 160 mm X 12 mm • Web Plate: 350 mm X 10 mm Take yield stress $f_y = 250$ MPa.	**07**
		OR	
	(c)	A fixed-ended beam of span 6 m is subjected to a factored uniformly distributed load of 35 kN/m over the left half of the span. Find the required plastic moment capacity Mp of the beam section at collapse.	**07**
Q.3	**(a)**	Explain the structural functions of longitudinal, plan, and diagonal bracing systems in industrial steel buildings.	**03**
	(b)	Derive the collapse load for a continuous beam of two equal spans of length L loaded with a concentrated load W at the center of each span. The beam has a constant plastic moment capacity Mp.	**04**

	(c)	Design a suitable angle section purlin for a roof truss with a span of 3.6 m. The pitch of the roof truss is 22°. The purlin is continuous over four supports and carries a working uniformly distributed load of 2.2 kN/m (excluding self-weight) acting perpendicular to the roof surface.	**07**

OR

Q.3	**(a)**	Explain the engineering concept of 'Prying Action' in bolted connections. Suggest practical design measures to minimize its effects.	**03**
	(b)	Sketch and distinguish between a beam-to-column web angle framed connection and a beam-to-column stiffened seat connection.	**04**
	(c)	Design a double-angle web cleat connection to link a secondary floor beam ISMB 350 to the web of a primary girder ISMB 450. The secondary beam transmits a factored end shear force of 180 kN. Use M20 bolts of Grade 4.6.	**07**
Q.4	**(a)**	Discuss the minimum web thickness requirements of plate girders based on serviceability and buckling criteria as recommended by IS 800:2007.	**03**
	(b)	Explain the 'Tension Field Method' used to evaluate the shear capacity of a thin web in a plate girder.	**04**
	(c)	Sizing and design a suitable cross-section (web depth, web thickness, flange width, and flange thickness) of a welded plate girder spanning 18 m. The girder is subjected to a factored uniformly distributed load of 65 kN/m over the entire span (inclusive of self-weight). Assume no intermediate transverse stiffeners are provided.	**07**

OR

Q.4	**(a)**	What is a gantry girder? Detail with a neat sketch how various lateral and longitudinal forces act on a gantry girder during crane operations.	**03**
	(b)	Discuss the limiting serviceability deflection criteria for gantry girders supporting hand-operated versus electrically operated overhead traveling (EOT) cranes as per IS 800:2007.	**04**
	(c)	A gantry girder is to be designed for an industrial shed with a span of 6 m. The effective span of the crane girder is 15 m. Weight of the crane girder excluding trolley is 180 kN, and the crane lifting capacity is 220 kN. Weight of the trolley (crab) is 50 kN. Minimum hook approach is 1.0 m, and the wheel base is 3.2 m. Determine the maximum vertical wheel load on the gantry girder, including impact allowance.	**07**
Q.5	**(a)**	Explain the fundamental layout differences between 'through-type' and 'deck-type' pedestrian foot-over bridges with neat schematic sketches.	**03**
	(b)	Discuss the structural layout and design criteria of the floor system (cross-beams and stringers) in an N-type pedestrian truss bridge.	**04**
	(c)	Design a bottom chord tension member for a panel in a pedestrian bridge truss subjected to a factored tensile force of 380 kN. Use double angle sections placed back-to-back on either side of a 10 mm gusset plate. Design the bolted end connection using M20 bolts of Grade 4.6.	**07**

OR

Q.5	**(a)**	Explain the effects of seismic (earthquake) loads on steel frames. Define how 'Response Reduction Factor' (R) influences the design base shear.	**03**
	(b)	Describe the engineering design steps to verify a steel beam web against 'web buckling' and 'web crippling' at supports.	**04**

(c) A through-type pedestrian foot-over bridge has a span of 20 m with 8 equal panels of 2.5 m each. The truss height is 2.5 m. The clear width of the walkway is 3.5 m. The floor system consists of a 100 mm thick RCC floor slab with a 20 mm floor finish. Pedestrian live load is 5 kN/m^2. Calculate the dead load and live load acting at an intermediate panel point of the bottom chord of the main truss. **07**

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