BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: BTECH **SEMESTER : V/ADD**
BRANCH: MECH **SESSION : MO/2025**

SUBJECT: ME355 ADVANCED SOLID MECHANICS

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1	Given the following state of stress at a point in a material: $$[\sigma_{ij}] = \begin{bmatrix} 80 & 45 & 0 \\ 45 & -35 & 0 \\ 0 & 0 & -50 \end{bmatrix} \text{MPa}$$ Calculate: i) The principal stresses ii) The maximum shear stress and iii) The octahedral shear stress.	[10]	1	3
Q.2	A prismatic beam of length L, flexural rigidity EI, and subjected to an axial compressive force P, is also loaded laterally with a uniform load q per unit length as shown in Fig 1. Given that the general differential equation for a beam-column is known, outline the systematic steps needed to find the most simplified expression for the lateral deflection y(x) for this beam. Include the form of complementary and particular solutions, discuss the impact of boundary conditions, and explain any special considerations for instability due to the axial load.	[10]	2	3

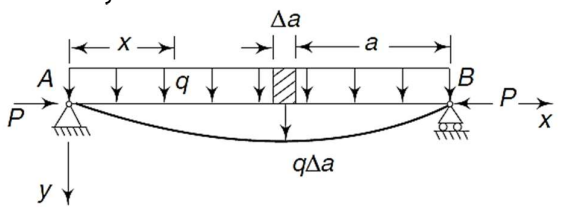

Fig 1

Q.3	For the fixed equal-leg angle section beam shown in Fig 2, weighing 1.48 N/cm. Now (i) Determine the principal axes (u, v) and principal area moments of inertia (I_{uu}, I_{vv}) for the cross-section. (ii) Find the orientation of the neutral axis (NA) relative to the geometric y-z axes. (iii) the stresses at point A due to self-weight. (iv) On a graph paper, with proper scale, accurately plot the principal axes and neutral axis with respect to the cross-section, showing their angles and relationship relative to the given x, y, and z coordinate system as represented in the figure.	[10]	3	3

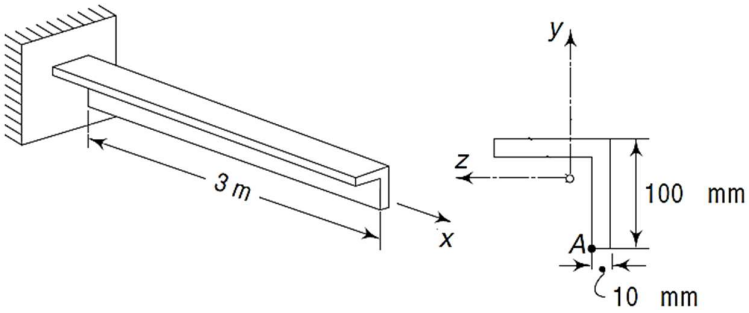

Fig 2

PTO

Q.4	Starting from the consideration of an infinitesimal element of a general non-circular cross section, prove that the torsion T developed is equal to twice the volume bounded by the Prandtl stress function ϕ surface and the cross section. Provide a clear physical interpretation of this volume with a neat sketch illustrating the Prandtl stress function surface over the cross section. Discuss how this volume relates to the torsional behavior of the bar.	[10]	4	4
Q.5	Consider a thin, solid circular disk of radius b subjected to a temperature distribution T(r) symmetrical about its center. Derive the expressions for the radial and hoop thermal stress components in the disk. In your derivation, critically analyze the assumptions made regarding plane stress conditions, isotropic material properties, and the nature of thermal expansion constraints. Further, discuss how the symmetry of T(r) affects stress distribution and comment on any potential singularities or boundary behavior in the derived expressions.	[10]	5	4

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