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

CLASS: B. TECH **SEMESTER : III**
BRANCH: CIVIL **SESSION : MO/2025**

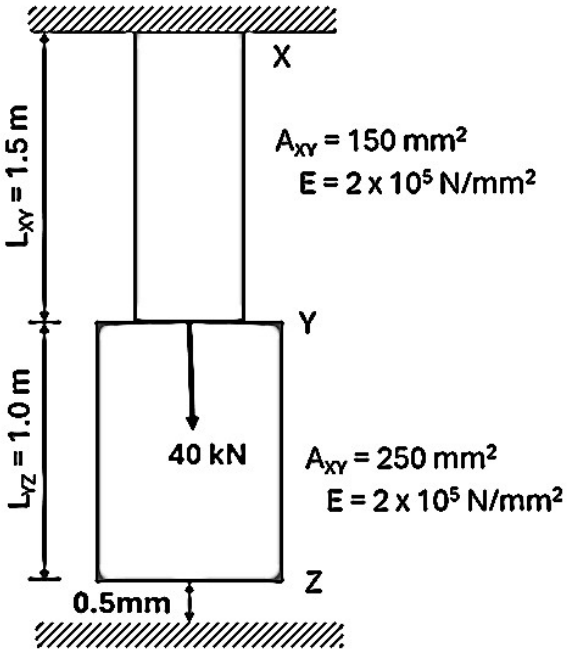
SUBJECT: CE24201 SOLID MECHANICS

TIME: 02 Hours **FULL MARKS: 25**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 5 marks and total 25 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates**

			CO	BL
Q.1	A tensile test was performed on an aluminum bar. The following results were recorded: • Diameter of the specimen = 12 mm • Original gauge length = 100 mm • Load at proportionality limit = 28 kN • Extension at a load of 20 kN = 0.09 mm • Maximum load at failure = 36 kN • Final gauge length = 128 mm • Diameter of specimen at fracture = 8 mm Determine: (a) Young's modulus (b) Stress at proportionality limit (c) True breaking stress (d) Percentage elongation (e) Percentage reduction in cross-sectional area	[5]	CO1	Apply Analyze
Q.2	An aluminum power line of span $L = 120\,\mathrm{m}$ is hung between two poles at an installation temperature of $15^{\circ}\mathrm{C}$. Material properties: $E = 70\,\mathrm{GPa}$, $\alpha = 23 \times 10^{-6}/^{\circ}\mathrm{C}$ The maximum summer temperature is $45^{\circ}\mathrm{C}$, and the lowest winter temperature is $-5^{\circ}\mathrm{C}$. At installation, the line is given a slack (sag) of 40 cm so that it can expand or contract freely without pulling hard on the poles. (a) Find how much the line increases in length in summer. (b) If there was no slack provided, what tensile stress would develop in the line in winter? (c) With 40 cm slack provided, check whether the line will remain free from stress in both summer and winter. (d) If the designer wants to keep the winter tensile stress within 30 MPa, what minimum slack should be provided? (e) Explain in simple words why power lines look more sagging in summer afternoons and tighter in winter mornings.	[5]	CO1	Apply Analyze Understand
Q.3	A stepped bar XYZ is rigidly fixed at the top end X and supported at the lower end Z as shown in figure. There is an initial gap of 0.5 mm at support Z. A load of 40 kN is applied downward at the junction Y. The length, Area and Modulus of elasticity is specified in the figure. Determine: a) Determine the reactions R1 at the fixed end X and R2 at support Z. b) Compute the stresses in the two sections XY and YZ.	[5]		Apply Analyze

PTO



Q.4 At a point in strained material, the following stresses act on two perpendicular planes: [5] CO2 Apply Analyze

- A tensile stress of 60 MPa on the x-face,
- A compressive stress of 40 MPa on the y-face,
- A shear stress of 30 MPa acting on the x-face in the downward direction.

a) Draw a neat sketch of the element rotated to its principal orientation, clearly showing the directions and magnitude of the principal stresses.
b) Normal and shear stress components on a plane inclined at 25^0 counterclockwise from the x-axis.

Q.5 For each of the following stress states at a point, sketch the Mohr's **Circle** and describe its key features (center, radius, and whether it degenerates to a point or line): [5] CO2 Understand

a) Pure Uniaxial Tension
b) Equal Biaxial Tension (Hydrostatic State)
c) Pure Shear Stress

:::::18/09/2025:::::E