

# DIPLOMA WALLAH

Jharkhand University of Technology (JUT)

## Engineering Mechanics and Strength of Materials

Full Marks: 70

Time: 3 Hours

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### **Instructions:**

- Question No. 1 is compulsory (7 MCQs, 2 Marks each).
- Answer any FOUR questions from the remaining (Q.2 to Q.7).
- Assume suitable data wherever missing and state it clearly.

**Q1. Choose the correct option for the following:**

**(7 × 2 = 14)**

**i. Poisson's ratio is defined as the ratio of:**

- a. Lateral strain to linear strain
- b. Linear strain to lateral strain
- c. Shear stress to shear strain
- d. Volumetric strain to linear strain

**ii. The point of contraflexure occurs in a beam when:**

- a. Shear force is zero
- b. Bending moment is maximum
- c. Bending moment changes sign
- d. Deflection is maximum

**iii. According to Hooke's law, stress is directly proportional to strain within:**

- a. Yield point
- b. Elastic limit
- c. Plastic limit
- d. Ultimate strength

**iv. The unit of Moment of Inertia of an area is:**

- a.  $\text{mm}^2$
- b.  $\text{mm}^3$
- c.  $\text{mm}^4$
- d.  $\text{kg-mm}^2$

v. Lami's theorem is applicable only for:

- a. Two concurrent forces in equilibrium
- b. Three concurrent forces in equilibrium
- c. Three non-concurrent forces
- d. Four coplanar forces

vi. For a simply supported beam of length 'L' carrying a uniformly distributed load of 'w' per unit length, the maximum bending moment is:

- a.  $wL/2$
- b.  $wL^2/4$
- c.  $wL^2/8$
- d.  $wL^3/12$

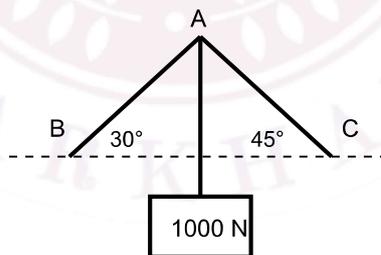
vii. The ratio of effective length to least radius of gyration of a column is called:

- a. Poisson's ratio
- b. Slenderness ratio
- c. Buckling factor
- d. Flexural rigidity

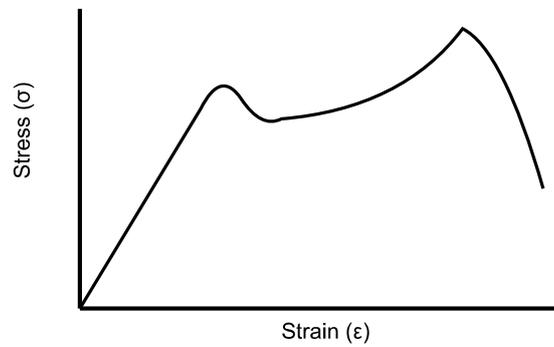
Q2.

(14)

A. A weight of 1000 N is supported by two strings AB and AC. The string AB makes an angle of  $30^\circ$  with the horizontal, and AC makes an angle of  $45^\circ$  with the horizontal. Calculate the tension in both strings using Lami's Theorem. [7]



B. Draw the Stress-Strain curve for mild steel under tension. Clearly mark and explain the significance of the Proportional limit, Elastic limit, Yield point, and Ultimate stress. [7]



**Q3. (14)**

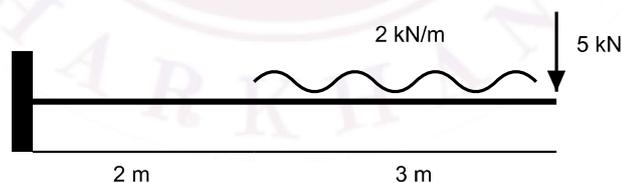
**A.** A stepped brass bar is subjected to axial forces as shown in the figure. Find the total elongation of the bar. Take  $E = 100 \text{ GPa}$ . [7]



**B.** State the assumptions made in the Theory of Simple Bending. Derive the Flexural formula:  $M/I = \sigma/y = E/R$ . [7]

**Q4. (14)**

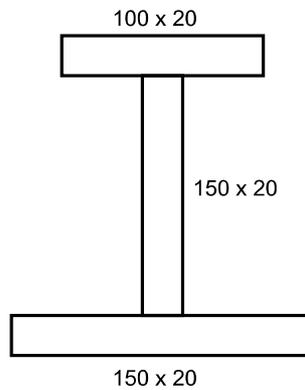
**A.** A cantilever beam 5 meters long carries a uniformly distributed load of  $2 \text{ kN/m}$  over a length of 3 meters from the free end, and a point load of  $5 \text{ kN}$  at the free end. Draw the Shear Force Diagram (SFD) and Bending Moment Diagram (BMD). [7]



**B.** Differentiate between Centre of Gravity and Centroid. State the Parallel Axis Theorem and Perpendicular Axis Theorem. [7]

**Q5. (14)**

**A.** An unsymmetrical I-section has the following dimensions: Top flange  $100\text{mm} \times 20\text{mm}$ , Web  $150\text{mm} \times 20\text{mm}$ , and Bottom flange  $150\text{mm} \times 20\text{mm}$ . Calculate the position of the centroid and the Moment of Inertia about its horizontal centroidal axis ( $I_{xx}$ ). [7]



**B.** Define Thermal Stresses. A steel rod 20m long is at a temperature of 20°C. Find the free expansion of the rod when the temperature is raised to 65°C. Also, find the temperature stress produced if the expansion is fully prevented. (Take  $E = 200 \text{ GPa}$ ,  $\alpha = 12 \times 10^{-6} / ^\circ\text{C}$ ). [7]

**Q6.** (14)

**A.** Explain Euler's column theory. Write down Euler's formula for crippling load for different end conditions (with sketches of effective lengths). [7]

**B.** What are Elastic Constants? Define Young's Modulus (E), Bulk Modulus (K), and Modulus of Rigidity (G), and write the relationship between them. [7]

**Q7. Write short notes on any FOUR of the following:** (4 × 3.5 = 14)

- Section Modulus and Flexural Rigidity
- Types of Beams and Supports (with sketches)
- Point of Contraflexure
- Principle of Transmissibility of Forces
- Differentiate between Short and Long Columns

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## Answer Key & Solutions

### MCQ Answer Key

i(a), ii(c), iii(b), iv(c), v(b), vi(c), vii(b)

### Model Answers (Hints)

- **Q2A (Lami's Theorem):** Apply  $P/\sin(\alpha) = Q/\sin(\beta) = R/\sin(\gamma)$ . Angles are  $120^\circ$ ,  $135^\circ$ , and  $105^\circ$ .
- **Q3A (Stepped Bar):** Find forces in sections using Superposition.  $\Delta L = \Sigma(PL/AE)$ .
- **Q4A (SFD/BMD):** Fixed end max BM. Parabolic curve for UDL part, linear for point load.
- **Q5A (I-Section MOI):** Find centroid  $y_{\text{bar}} = \Sigma(Ay)/\Sigma A$ . Apply Parallel Axis Theorem  $I_{xx} = \Sigma[I_G + A(y_{\text{bar}} - y)^2]$ .

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