

# 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).
- Use of scientific calculators is permitted.
- Assume suitable data wherever missing and state it clearly.

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

(7 × 2 = 14)

#### **i. The property of a material by which it can be beaten or rolled into thin sheets is called:**

- a. Malleability
- b. Ductility
- c. Plasticity
- d. Elasticity

#### **ii. The bending moment at the free end of a cantilever beam is always:**

- a. Maximum
- b. Minimum
- c. Zero
- d. Equal to shear force

#### **iii. Modulus of rigidity (G) is defined as the ratio of:**

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

#### **iv. The distance of the centroid of a semicircle of radius 'R' from its base is:**

- a.  $4R / 3\pi$
- b.  $3R / 4\pi$
- c.  $R / 2$
- d.  $R / 3$

v. In a simply supported beam carrying a uniformly distributed load (UDL) over its entire length, the maximum shear force occurs at:

- a. Center of the beam
- b. The supports
- c. One-third of the length
- d. Point of contraflexure

vi. The maximum stress produced in a bar of tapering section subjected to an axial load occurs at:

- a. The larger end
- b. The middle
- c. The smaller end
- d. Anywhere

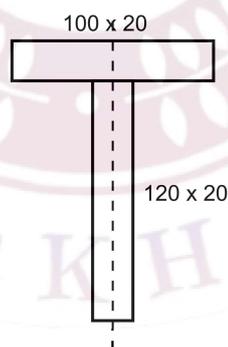
vii. The resultant (R) of two forces P and Q acting at an angle  $\theta$  is given by:

- a.  $R = P + Q$
- b.  $R = \sqrt{P^2 + Q^2 - 2PQ \cos\theta}$
- c.  $R = \sqrt{P^2 + Q^2 + 2PQ \sin\theta}$
- d.  $R = \sqrt{P^2 + Q^2 + 2PQ \cos\theta}$

**Q2.**

**(14)**

A. Find the centroid of a T-section with flange dimensions 100 mm × 20 mm and web dimensions 120 mm × 20 mm. [7]

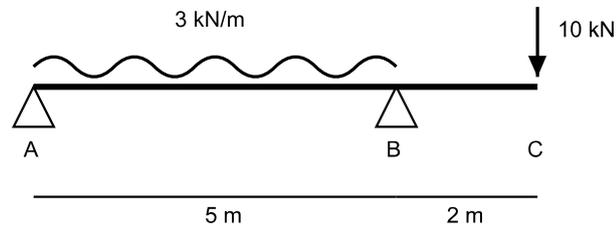


B. Explain the following mechanical properties of metals: (i) Malleability (ii) Ductility (iii) Toughness (iv) Hardness (v) Brittleness (vi) Creep (vii) Fatigue. [7]

**Q3.**

**(14)**

A. An overhanging beam ABC of length 7m is supported at points A and B, where AB = 5m and BC = 2m (overhang). It carries a UDL of 3 kN/m over the span AB and a point load of 10 kN at the free end C. Draw the Shear Force and Bending Moment diagrams. [7]



**B.** Derive the relationship between Young's Modulus ( $E$ ), Bulk Modulus ( $K$ ), and Poisson's ratio ( $1/m$  or  $\mu$ ).  
The relation is  $E = 3K(1 - 2\mu)$ . [7]

**Q4.** [14]

**A.** Two concurrent forces of 40 N and 60 N are acting at a point with an angle of  $60^\circ$  between them. Find the magnitude and direction of their resultant force. [7]

**B.** A rectangular timber beam 100 mm wide and 200 mm deep is simply supported over a span of 4 meters. Find the maximum uniformly distributed load (UDL) it can carry if the maximum bending stress is not to exceed 10 MPa. [7]

**Q5.** [14]

**A.** A steel rod of 25 mm diameter and 2 meters long is subjected to an axial pull of 45 kN. Calculate the stress, strain, and total elongation of the rod. Take  $E = 200$  GPa. [7]

**B.** What are statically determinate and statically indeterminate beams? Explain with the help of sketches and give at least two examples of each. [7]

**Q6.** [14]

**A.** Explain the Moment Area Method to determine the slope and deflection of a beam. State Mohr's First and Second Theorems. [7]

**B.** Differentiate between concurrent, non-concurrent, collinear, and coplanar force systems with neat sketches. [7]

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

- Hooke's Law and its limitations
- Assumptions made in Euler's Column Theory
- Polar Moment of Inertia and Radius of Gyration
- Thermal Stresses in composite bars
- Shear stress distribution diagram over a rectangular and circular section

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## Answer Key & Solutions

### MCQ Answer Key

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

### Model Answers (Hints)

- **Q2A (T-Section Centroid):** Take bottom as reference axis.  $A_1 = 120 \times 20$ ,  $y_1 = 60$ .  $A_2 = 100 \times 20$ ,  $y_2 = 120 + 10 = 130$ .  $y_{\text{bar}} = (A_1 y_1 + A_2 y_2) / (A_1 + A_2)$ . Output is the distance from the bottom.
- **Q3A (Overhanging SFD/BMD):** First calculate  $R_A$  and  $R_B$  by taking moments about A and B.  $R_A + R_B = (3 \times 5) + 10$ . Draw SFD showing step changes at supports and linear variation under UDL. BMD will be parabolic in AB and linear in BC. Max bending moment occurs where  $SF = 0$  in span AB.
- **Q4A (Resultant Force):** Use Parallelogram Law.  $R = \sqrt{(40^2 + 60^2 + 2 \times 40 \times 60 \times \cos 60^\circ)}$ . Direction  $\alpha = \tan^{-1}((60 \times \sin 60^\circ) / (40 + 60 \times \cos 60^\circ))$ .
- **Q4B (Bending Stress):** Given  $b = 100$ ,  $d = 200$ ,  $\sigma_{\text{max}} = 10$ .  $I = bd^3/12$ .  $y_{\text{max}} = d/2 = 100$ . Find  $M$  from  $M/I = \sigma/y$ . For simply supported beam with UDL,  $M_{\text{max}} = wl^2/8$ . Equate and find 'w'.
- **Q5A (Stress & Strain):** Area  $A = (\pi/4) \times 25^2$ . Stress  $\sigma = P/A$ . Strain  $\epsilon = \sigma/E$ . Elongation  $\Delta L = \epsilon \times L$ . Convert all units to N and mm.

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