DIPLOMA WALLAH

Jharkhand University of Technology (JUT)

Engineering Mechanics and Strength of Materials

Full Marks: 70 **Time: 3 Hours**

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 center of gravity of a solid cone of height 'h' lies at a distance of:

a. h/2 from base

b. h/3 from base

c. h/4 from base

d. 3h/8 from base

ii. Euler's crippling load for a column with one end fixed and the other end free is:

a. π^2EI / L^2

b. $\pi^2EI / 4L^2$

c. $2\pi^2EI / L^2$

d. $4\pi^2EI / L^2$

iii. The unit of strain is:

a. N/mm^2

b. N/m

c. Dimensionless (No unit)

d. kg/cm^2

iv. A beam supported on more than two supports is called a:

a. Fixed beam

b. Cantilever beam

c. Continuous beam

d. Overhanging beam

v. When a body is subjected to three mutually perpendicular stresses, the ratio of direct stress to volumetric strain is called:

a. Young's Modulus

b. Modulus of Rigidity

c. Bulk Modulus

d. Poisson's Ratio

vi. The polar moment of inertia of a solid circular section of diameter 'D' is:

a. $\pi D^4 / 64$

b. $\pi D^4 / 32$

c. $\pi D^3 / 32$

d. $\pi D^4 / 16$

vii. The shear force at the center of a simply supported beam carrying a uniformly distributed load (UDL) over its entire length is:

a. Maximum

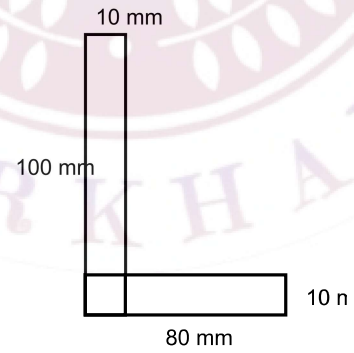
b. Zero

c. Minimum but not zero

d. Half of the maximum shear force

Q2. **(14)**

A. An unequal angle section (L-Section) has dimensions 100 mm × 80 mm × 10 mm. Calculate the position of its centroid. (Assume the longer leg is vertical). **[7]**

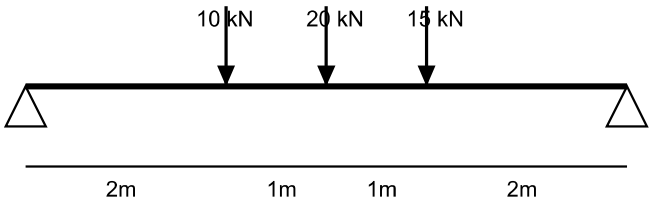


B. What is a Free Body Diagram (FBD)? Draw the FBD of a ladder resting against a smooth vertical wall and a rough horizontal floor, carrying a man at its center. **[7]**

Q3. **(14)**

A. A simply supported beam of span 6 meters is carrying point loads of 10 kN, 20 kN, and 15 kN at distances of 2m, 3m, and 4m respectively from the left support. Draw the Shear Force Diagram (SFD) and

Bending Moment Diagram (BMD). **[7]**



B. Derive an expression for the total elongation of a uniformly tapering circular bar of length 'L' having diameters D_1 and D_2 at its ends, subjected to an axial pull 'P'. **[7]**

Q4. **(14)**

A. State and prove Varignon's Theorem (Principle of Moments). **[7]**

B. A steel wire of 5 mm diameter is bent into a circular shape of 5 meters radius. Determine the maximum bending stress induced in the wire. Take E = 200 GPa. **[7]**

Q5. **(14)**

A. A composite bar consists of a solid steel rod of 20 mm diameter coaxially enclosed in a copper tube of 40 mm external diameter and 20 mm internal diameter. The assembly is 1 meter long and is subjected to an axial compressive load of 50 kN. Find the stresses in the steel rod and copper tube. (Take E_steel = 200 GPa, E_copper = 100 GPa). **[7]**

B. Prove that the maximum shear stress in a rectangular section of a beam is 1.5 times the average shear stress. **[7]**

Q6. **(14)**

A. Compare Euler's formula and Rankine's formula for columns. Write down Rankine's formula and explain the significance of the empirical constant 'a'. **[7]**

B. Using the Method of Joints, determine the forces in all the members of a simple triangular truss ABC resting on supports at A and B, with a point load applied at the apex C. (Assume ABC is an equilateral triangle of side 3m, load at C = 10 kN). **[7]**

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

a. Perfect, Imperfect, and Deficient Trusses

b. Factor of Safety and its significance

c. Neutral Axis and Moment of Resistance

d. Slenderness Ratio and Effective Length of columns

e. Methods of determining the deflection of a beam

📑 Answer Key & Solutions

MCQ Answer Key

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

Model Answers (Hints)

- **Q2A (L-Section Centroid):** Divide into 2 rectangles: Vertical (100x10) and Horizontal (70x10). A1=1000, A2=700. Use x_bar = Σ(Ax)/ΣA and y_bar = Σ(Ay)/ΣA from bottom left corner.
- **Q3A (SS Beam SFD/BMD):** First find Support Reactions R_A and R_B using ΣM_A = 0 and ΣF_y = 0. SFD will look like stairs stepping down at each point load. BMD will be a series of straight lines connecting peak moments under each load.
- **Q3B (Tapering Bar):** Consider a small element dx at distance x. Find diameter at x. Stress = P / Area_x. Strain = Stress/E. Integrate from 0 to L. Result is $\Delta L = 4PL / (\pi E D_1 D_2)$.
- **Q4B (Bending Stress):** Use bending equation E/R = σ/y. Given E=200x10³ N/mm², R=5000 mm. For a 5mm wire, y_max = d/2 = 2.5 mm. Calculate σ = (E * y) / R = 100 MPa.
- **Q5A (Composite Section):** Strain is equal in both materials: σ_s/E_s = σ_c/E_c. Total Load P = P_s + P_c = σ_s*A_s + σ_c*A_c. Solve these two simultaneous equations for σ_s and σ_c.