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**Third Semester B.E. Degree Examination, June/July 2024**  
**Strength of Materials**

Time: 3 hrs.

Max. Marks: 100

*Note: Answer any FIVE full questions, choosing ONE full question from each module.*

**Module-1**

- 1 a. With a neat sketch, define salient features of stress-strain curve for a tensile specimen for mild steel. (06 Marks)
- b. Derive the expression for elongation of tapering circular bar due to an axial load P. (06 Marks)
- c. A tension test was conducted on mild steel bar and the following data was obtained from the test:  
 Diameter of the bar = 18mm  
 Gauge length of the bar = 82mm  
 Load at proportional limit = 75kN  
 Extension at a load of 62kN = 0.113mm  
 Load at failure = 82kN  
 Final gauge length of the bar = 106mm  
 Diameter of the bar at failure = 14mm  
 Determine the Young's modulus, proportional limit, true breaking stress, % elongation and percentage reduction in cross sectional area. (08 Marks)

**OR**

- 2 a. Define the four elastic constants. (04 Marks)
- b. Define principle of superposition and thermal stress. (04 Marks)
- c. At a point in an elastic material, the stresses on two perpendicular planes are  $80\text{N/mm}^2$  (tensile) and  $60\text{N/mm}^2$  (compressive). There is also a shear stress of  $40\text{N/mm}^2$ . Find the normal stress and shear stress on a plane making an angle of  $30^\circ$  with the plane on which the tensile stress acts. Also find the values of principal stresses and the location of principal planes (adopt analytical method). (12 Marks)

**Module-2**

- 3 a. Define:  
 i) Shear force  
 ii) Bending moment  
 iii) Point of contraflexure. (06 Marks)
- b. Draw SFD and BMD for a simply supported beam subjected to a couple moment 'M' in clockwise direction acting at a distance of 'a' from left support and 'b' from right support. (06 Marks)
- c. Sketch SFD and BMD for the beam shown in Fig.Q.3(c) indicating salient points.

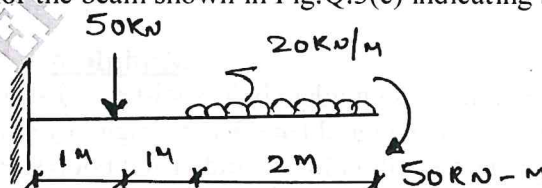


Fig.Q.3(c)

(08 Marks)

OR

- 4 a. Derive relationship between load intensity, shear force and bending moment. (06 Marks)  
 b. Draw BMD and SFD for the overhanging beam shown in Fig.Q.4(b). Clearly indicate the position of contra flexure. (14 Marks)

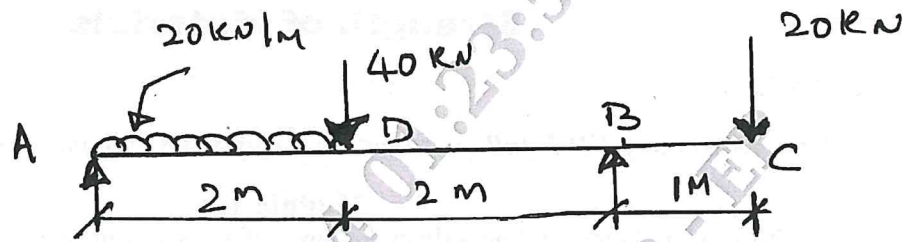
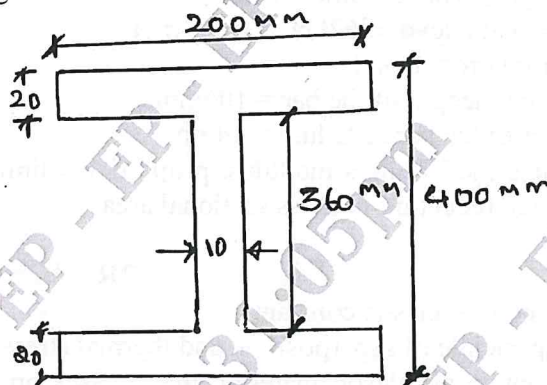


Fig.Q.4(b)

**Module-3**

- 5 a. List the assumptions in simple theory of bending. (04 Marks)  
 b. Derive the bending equation with usual notations. (08 Marks)  
 c. A rolled steel joist of I-section has the dimension as shown in Fig.Q.5(c). This beam of I-section carries a UDL of 40kN/m run on a span of 10m. Calculate the maximum stress produced due to bending. (08 Marks)



All dimensions in mm

Fig.Q.5(c)

OR

- 6 a. Define:  
 i) Section Modulus  
 ii) Modulus of rupture  
 iii) Moment of resistance. (03 Marks)  
 b. Prove that maximum shear stress in a rectangular section of width 'b' and depth 'd' is equal to 1.5 times of its average shear stress. (05 Marks)  
 c. A 'T' section of flange 120mm × 12mm and overall depth 200mm with 12mm web thickness is loaded such that at a section it has a bending moment of 20kNm and shear force of 120kN. Sketch the bending and shear stress distribution diagram marking the salient values. (12 Marks)

**Module-4**

- 7 a. Prove that a hollow circular shaft is stiffer and stronger than a solid circular shaft in torsion which have same material length and weight, by strength and stiffness criteria. (10 Marks)  
 b. Derive Lamé's equation for the radial and hoop stress for thick cylinder subjected to internal and external fluid pressure. (10 Marks)

OR

- 8 a. Determine the maximum and minimum hoop stress across the section of a pipe of 400mm internal diameter and 100mm thick, when the pipe contains a fluid at a pressure of  $8\text{N/mm}^2$ . Also sketch the radial pressure distribution and hoop stress distribution. (10 Marks)
- b. A shaft of hollow cross section rotates at 200rpm transmitting a power of 800kW with internal diameter = 0.8 times external diameter. Compute the diameters if the maximum shear stress is limited to  $100\text{N/mm}^2$  and the angle of twist to  $1^\circ$  in a length of 4m. Assume that the maximum torque is 30% greater than the mean torque and  $G = 80\text{GPa}$ . (10 Marks)

**Module-5**

- 9 a. Derive an expression for slope and deflection in a simply supported beam subjected to UDL throughout. Calculate the maximum slope and deflection. (06 Marks)
- b. Define: i) Buckling load ii) Effective length iii) Slenderness ratio. (06 Marks)
- c. Compute the crippling loads using Euler's and Rankine's formula for a hollow circular column 200mm external diameter and 25mm thick. The length of the column is 4m with both ends hinged. Assume  $E = 200\text{GPa}$ , Rankine's constants  $\sigma_c = 320\text{MPa}$  and  $a = 1/7500$ . (08 Marks)

OR

- 10 a. Derive an equation for buckling load in a long column with both ends hinged using Euler's column theory. (08 Marks)
- b. State the assumptions made in Euler's theory. (04 Marks)
- c. A simply supported beam of length 40m is subjected to a UDL of  $30\text{kN/m}$  over the whole span and deflects 15mm at the centre. Determine the crippling loads when this beam is used as a column with the following conditions: i) One end fixed and other end hinged ii) Both ends pin jointed [Take length of beam  $l = 4000\text{mm}$  and UDL,  $W = 30\text{kN/m}$ , Deflection at centre = 15mm]. (08 Marks)

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