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## Third Semester B.E. Degree Examination, Dec.2018/Jan.2019 Mechanics of Materials

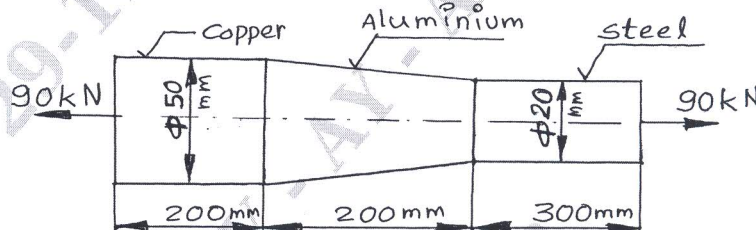
Time: 3 hrs.

Max. Marks: 100

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

### Module-1

- 1 a. Derive the expression for elongation in taper round bar of length ' $l$ ', tapering uniformly for diameter ' $d_1$ ' to ' $d_2$ ' and subjected to an axial load of ' $F$ ' modulus of elasticity is  $E$ . (10 Marks)
- b. Find the elongation in a bar loaded as shown in Fig.Q.1(b). Take modulus of elasticity for steel  $E_S = 200\text{GPa}$ , for copper  $E_C = 100\text{GPa}$  and for aluminium  $E_A = 70\text{GPa}$ . (10 Marks)



OR

- 2 a. Derive relation between Young's modulus " $E$ " and rigidity modulus " $G$ ". (10 Marks)
- b. A steel rail 12.6m long is laid at temperature of  $24^\circ\text{C}$ . The maximum temperature is  $44^\circ\text{C}$ . Estimate the minimum gap between the rails so that the temperature stresses do not develop. Also calculate the thermal stresses developed in rails if no gap is provided between rails. If an expansion of 2mm is allowed, what is the stress induced. Take  $E = 200\text{GPa}$ ,  $\alpha = 12 \times 10^{-6}/^\circ\text{C}$ . (10 Marks)

### Module-2

- 3 a. Derive an expression for normal and shear stresses on an oblique plane inclined at ' $\theta$ ' with vertical axis ( $x$ -plane) in a biaxial system subjected to stresses  $\sigma_x$  and  $\sigma_y$  on mutually perpendicular axes. (08 Marks)
- b. For an element loaded as shown in the Fig.Q.3(b), find:
  - i) Normal and shear stresses along inclined plane BE.
  - ii) Principal stresses and their angles
  - iii) Maximum shear stress and shear planes. (12 Marks)

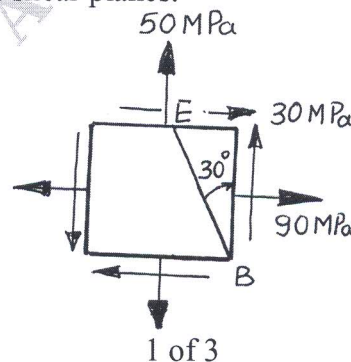


Fig.Q.3(b)

OR

- 4 a. Derive expressions for circumferential and longitudinal stresses for a thin cylinder of diameter 'd', length 'l' and thickness 't' subjected to internal pressure 'p'. (10 Marks)
- b. A pipe of internal diameter 300mm and wall thickness of 100mm contains fluid under a pressure of 6MPa. Calculate and sketch the radial and hoop stresses induced across the wall. (10 Marks)

**Module-3**

- 5 Draw the shear force and bending moment diagrams for a beam loaded as shown in Fig.Q.5. Determine the location of point of contraflexure. Also find maximum bending moment and its location. (20 Marks)

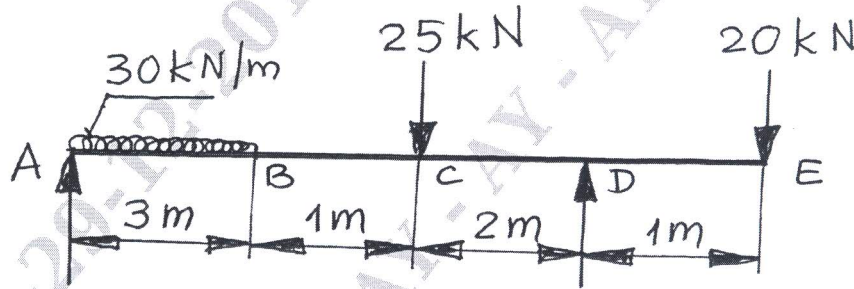


Fig.Q.5

OR

- 6 a. Derive the equation of bending  $\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$ . (10 Marks)
- b. A simply supported beam of span 3m has T-cross section. The flange is 100mm  $\times$  20mm and the web is 200mm  $\times$  12mm, with the flange in compression. The maximum compressive stress is to be limited to 90MPa. Find the maximum intensity of UDL that can be carried and the corresponding tensile stress induced. (10 Marks)

**Module-4**

- 7 a. Derive the equation of torsion  $\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}$ . (10 Marks)
- b. A shaft transmits 180kW at 240rpm. The allowable shear stress is 72MPa.
- Find the diameter of solid shaft.
  - Also find the diameters of hollow shaft if the inside diameter is 0.6 times its outside diameter.
  - What is the percentage of saving of material if both shafts are of same material and length? (10 Marks)

OR

- 8 a. Derive an expression for Euler's critical load for a column with both ends pinned. (10 Marks)
- b. Find the Euler's critical load for a column 1.2m long of rectangular cross section 90mm wide, 60mm depth with both ends hinged. Modulus of elasticity is 200GPa. Compare it with Rankine's critical load taking Rankine's constants  $\sigma = 300$  MPa and  $\alpha = \frac{1}{7500}$ . (10 Marks)

**Module-5**

- 9 a. Derive an expression for strain energy for a member subjected to axial load. (05 Marks)  
b. Explain Castigliano theorem – I. (05 Marks)  
c. A round rod 120mm diameter, 1.8m long transmits 300kW at 900rpm. Find the maximum strain energy stored by the rod. Take  $G = 80,000 \text{ N/mm}^2$ . (10 Marks)

**OR**

- 10 a. Define:  
i) Strain energy  
ii) Modulus of resilience  
iii) Toughness (06 Marks)
- b. Find the diameter of round rod subjected to a bending moment of 1.8 kN-m and a torque of 1.2 kN-m, according to  
i) Maximum normal stress theory  
ii) Maximum shear stress theory.  
Take allowable normal stress as 120MPa and allowable shear stress as 72 MPa. (14 Marks)

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