U.S.N

P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fourth Semester, B.E. - Mechanical Engineering

Semester End Examination; May / June - 2019

Mechanics of Materials

Time: 3 hrs *Max. Marks: 100*

Note: *i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*
ii) Missing data, if any, may be suitably assumed. iii) Draw neat sketches wherever necessary.
iv) Show the detailed calculations indicating relevant steps.

UNIT - I

1 a. State and explain the principle of super position. 4

b. A tapering bar of length '*L*' has its diameter varying from (*d* + *a*) at one end to (d – a) at the other end. Prove that percentage error involved in the value of Young's modulus calculated using mean diameter is $\left(\frac{10a}{d}\right)^2$. 6

c. A steel specimen of 12.5 mm diameter and 150 mm gauge length is subjected to tensile test. It is observed that load at yield point is 43 kN and maximum load is 60 kN. A load of 16.4 kN is required to cause an elastic extension of 0.1 mm. Final length of specimen's 190 mm and the diameter of neck after fracture is 8 mm. Determine; 10

(i) Yield stress (ii) Ultimate stress (iii) Young's modulus

(iv) Percentage increase in length (v) Percentage reduction in area

2 a. A round bar with stepped portions is subjected to a force as shown in Fig. 2(a). Determine the magnitude of force '*P*' such that net deformation in the bar does not exceed 1 mm. Young's modulus of steel is 200 GPa and that for Aluminum is 70 GPa. Big end diameter and small end diameter of tapering bar are 40 mm and 12.5 mm respectively. 10

b. A 70 mm long block has cross-section of 50 mm × 10 mm. The block is subjected to forces 60 kN (tension) on (50 mm × 10 mm) face and 110 kN (compression) on (70 mm × 10 mm) face. Determine the force to be applied on (70 × 50 mm) face such that there is no change in volume. Take E = 200 GPa and Poisson's ratio γ= 0.3. 10

UNIT - II

3 a. A horizontal bar hinged at one of its ends is supported by two vertical bars as shown in Fig. 3(a). If the temperature of vertical bars is increased by 40°C. Determine the forces and deformations induced in them. Take $\alpha_c = 18\times10^{-6}$ /°C, $\alpha_s = 12\times10^{-6}$ /°C, E_C = 100 GPa and E_S = 200 GPa. 10

b. A compound bar consists of a solid copper bar and an aluminum tube of equal lengths arranged coaxially and has a rigid plates fixed on its either ends. Cross sectional area of copper bar and aluminum tube are 1000 mm^2 and 1600 mm^2 respectively. Taking the allowable stresses for a copper and aluminum as 140 MPa and 72 MPa respectively. Determine the maximum axial load that can be applied on the compound bar. Take E_{AL} = 70 GPa and E_{CO} = 140 GPa. 10

Contd….2

4 a. Prove that maximum shear stress is half the difference of principal stresses for a general two dimensional stress system. 8

b. A point in a body is subjected to tensile stresses 100 MPa and 70 MPa along two mutually perpendicular directions. The point is also subjected to shear stress of magnitude 50 MPa. Determine; 12

(i) Normal stress and shear stress acting on a plane which is at an angle of 120° with reference to the 100 MPa stress plane

(ii) Magnitudes of principal stresses and maximum and minimum shear stresses

(iii) Orientation of principal planes and maximum and minimum shear stress planes

(iv) Normal stress on the planes of maximum and minimum shear stresses

UNIT - III

5. Draw the Shear force and bending moment diagram for a beam subjected to forces as shown in Fig. Q(5). Also find the location of point of contra flexure and magnitude of maximum bending moment. 20

6. Draw the Shear force and bending moment diagrams for a beam subjected to loads as shown in Fig. Q(6). Also find the location of point of contra flexure and magnitude of maximum bending moment. 20

UNIT - IV

7 a. Derive an expression for flexural equation, $\frac{M}{I}=\frac{\sigma_b}{y}=\frac{E}{R}$ with assumptions. 6

b. A 2 m long cantilever with an un-symmetric '*I*' section is subjected to a UDL of 20 kN/m. The '*I*' section has (180 mm × 10 mm) upper flange (100 mm × 10 mm) bottom flange and (220 mm × 10 mm) web. Draw the bending stress and shear stress distribution diagrams. 14

8 a. Show that maximum deflection for simply supported beam subjected to a concentrated load at the centre is, $\frac{WL^3}{48EI}$. 10

b. A 2 m long cantilever is subjected to UDL of 10 kN/m through its length and a vertically downward point load 20 kN at its free end. Take; E = 200 GPa and maximum deflection as 0.3 mm. Determine the width and depth of rectangular section. Depth of the section is twice the width. 10

UNIT - V

9 a. State the assumptions made in pure torsion theory and derive an expression for shear stress produced in a circular shaft subjected to torsion. 10

b. Define slenderness ratio and derive Euler's expression for a column with both ends hinged. 10

10 a. Derive Euler's expression for crippling load in a column subjected to a compressive load when one end is fixed and other end is free. 10

Contd….3

b. A solid shaft rotating at 500 rpm transmits 30 kW. Maximum torque is 20% more than the mean torque. Material of the shaft has the allowable shear stress 65 MPa and modulus of rigidity 81 GPa. Angle at twist in the shaft should not exceed 1° in 1 m length. Determine the diameter of the shaft. 10

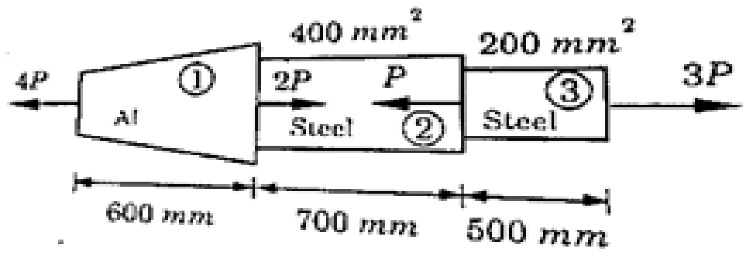

Figure 2(a)

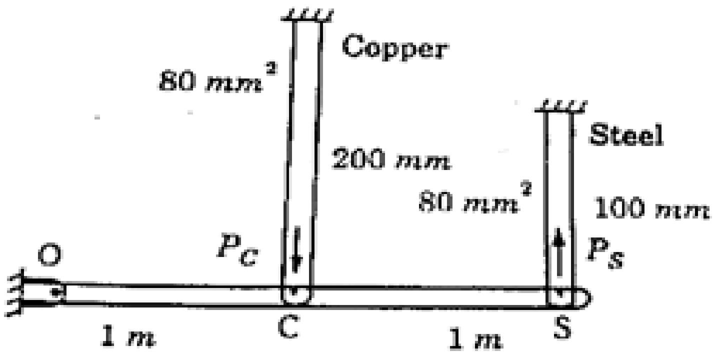

Figure 3(a)

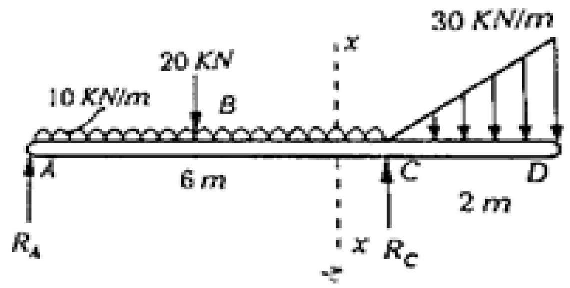

Figure Q(5)

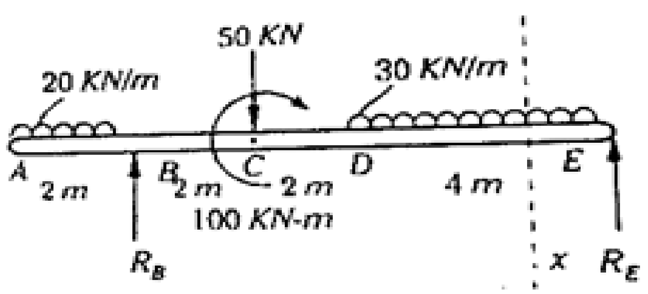

Figure Q(6)

* * * *