CBCS SCHEME

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15AU34

Third Semester B.E. Degree Examination, Dec.2019/Jan.2020
Mechanics of Materials

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. List and explain the mechanical properties of engineering materials. **(08 Marks)**

b. A steel bar ABCD of varying sections is subjected to the axial forces as shown in Fig.Q1(b). Find the value of 'P' necessary for equilibrium. If E = 210 kN/mm^2, determine: (i) Stress in various segments (ii) Total elongation (iii) Total strain in the bar.

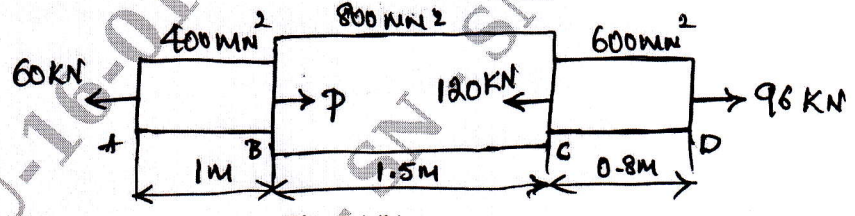

Fig.Q1(b) **(08 Marks)**

OR

2 a. A compound bar consisting of steel, Bronze and aluminum bars connected in series is held between two supports as shown in Fig.Q2(a). When the temperature of the compound bar is increased by 50°C, determine the stress induced in each bar. Consider the two cases:
(i) Rigid supports (ii) Supports yield by 0.5 mm
Take $\alpha_S = 12 \times 10^{-6}$/°C $\alpha_B = 19 \times 10^{-6}$/°C $\alpha_{Al} = 22 \times 10^{-6}$/°C,
$E_S = 200$ GPa $E_B = 83$ GPa $E_{Al} = 70$ GPa

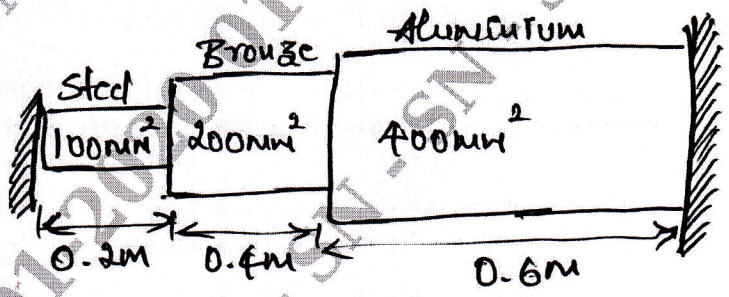

Fig.Q2(a) **(08 Marks)**

b. Show the relation between Young's modulus and modulus of rigidity. **(08 Marks)**

Module-2

3 a. Discuss: (i) Principal planes and principal stresses (ii) Maximum and minimum shear stresses, with respect to compound stress. **(08 Marks)**

b. Describe the construction of Mohr's circle for plane stress. **(08 Marks)**

OR

4 a. Derive an expression for circumferential stress and longitudinal stress corresponding to thin cylinders. **(08 Marks)**

b. A cylindrical pressure vessel of 1 meter inner diameter and 1.5 meters long is subjected to an internal pressure P_1 thickness of the cylinder wall is 15 mm. Taking allowable stress for cylinder material is 90 MPa. Determine: (i) Magnitude of maximum internal pressure 'P' that the pressure vessel can with stand and (ii) Change in dimensions. Take E = 200 GPa and $\mu = 0.3$ **(08 Marks)**

Module-3

5 a. Define and explain the following terms:
i) Shear force ii) Bending moment
iii) Bending moment diagram iv) Shear force diagram **(08 Marks)**

b. A simply supported beam of length 6m, carries point load of 3 kN and 6 kN at distance of 2m and 4m from the left end. Draw the shear force and bending moment diagrams for the beam. **(08 Marks)**

OR

6 a. Derive a relationship between bending stress and radius of curvature. **(08 Marks)**

b. Derive the deflection equation $EI = \frac{d^2y}{dx^2} = M$ **(08 Marks)**

Module-4

7 a. Derive the relation for a circular shaft when subjected to torsion as given by $\frac{T}{J} = \frac{\tau}{R} = \frac{G\theta}{L}$ **(08 Marks)**

b. A solid circular shaft has to transmit a power of 1000 kW at 120 rpm. Find the diameter of the shaft, if the shear stress of the material must not exceed 80 N/mm^2. The maximum torque 1.25 times of its mean. What percentage of saving in material would be obtained if the shaft is replaced by a hollow one whose internal diameter is 0.6 times its external diameter, the length, material and maximum shear stress being same? **(08 Marks)**

OR

8 a. Derive an expression for the Euler's Crippling load for a long column when both the ends of the column are hinged. **(08 Marks)**

b. A 1.5 m long column has a circular cross section of 50 mm diameter. One end of the column is fixed in direction and position and the other end is free. Taking the factor of safety as 3, calculate the safe load using:
i) Rankine's formula taking yield stress 560 N/mm^2 and $\alpha = 1/1600$
ii) Euler's formula, taking $E = 1.2 \times 10^5$ N/mm^2. **(08 Marks)**

Module-5

9 a. Derive an expression for strain energy due to shear stress. **(08 Marks)**
b. Write a note on Castigliano's theorem I and II. **(04 Marks)**
c. Define modulus of Resilence of strain energy. **(04 Marks)**

OR

10 a. A rod of circular section is to sustain a tensional moment of 300 kN-m and bending moment 200 kN-m. Selecting 45C8 steel (σ_{yt} = 353 MPa) and assuming factor of safety = 3. Determine the diameter of rod as per following theories of failure.
(i) Maximum shear stress theory (ii) Maximum principal stress theory **(10 Marks)**

b. Write notes on: (i) Maximum principal stress theory (ii) Maximum shear stress theory **(06 Marks)**

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