CBCS SCHEME

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17AU34

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. State the Hooke's law. Explain with neat sketch stress – Strain diagram for mild steel indicating its salient points. **(06 Marks)**

b. A steel bar ABCD of varying sections is subjected to the axial forces as show in Fig. Q1(b). Find the value of P necessary for equilibrium. If E = 210kN/mm^2, determine : i) stress in various segments ii) total elongation of bar iii) total strain in the bar. **(06 Marks)**

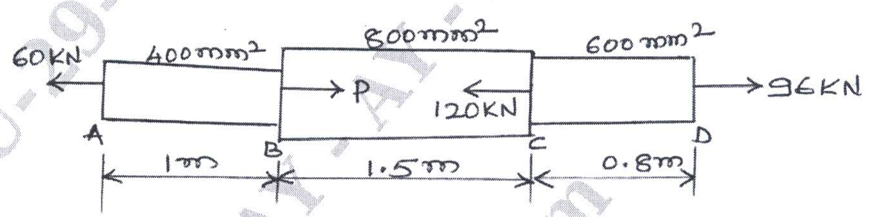

Fig.Q1(b)

c. A compound bar made of Aluminium and steel bars connected in series is fixed rigidly at its ends in vertical position. The length of aluminium portion is 150mm and that of steel portion is 300mm. Determine the stresses and deformations induced in the two portions, if the compound bar is subjected to a vertical load of 100 kN at its junction. Take $E_{A\ell}$ = 70 GPa, $A_{A\ell}$ = 1000mm^2, E_S = 200GPa and A_S = 1200mm^2. **(08 Marks)**

OR

2 a. Define the following :
i) Poisson's ratio ii) Bulk modulus iii) Thermal stress iv) True stress. **(04 Marks)**

b. A compound bar consisting of steel, copper and aluminium bars connected in series is held between two supports as shown in Fig.Q2(b). When the temperature of the compound bar is increased by 50°C, determine stresses induced in each bar. Consider the two cases i) rigid supports and ii) supports yield by 0.5mm. Take $\alpha_S = 12 \times 10^{-6}$/°C, $\alpha_B = 19 \times 10^{-6}$/°C, $\alpha_{A\ell} = 22\times 10^{-6}$/°C, E_S = 200GPa, E_B = 83GPa, $E_{A\ell}$ = 70 GPa. **(08 Marks)**

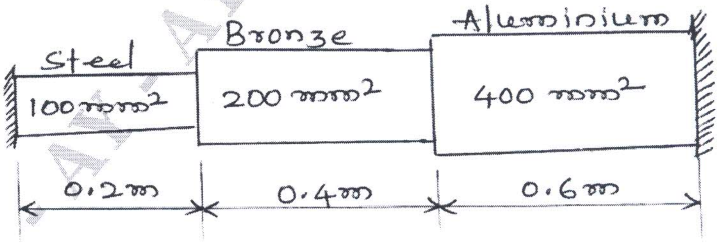

Fig.Q2(b)

c. Obtain the relation between Young's modulus (E) and modulus of rigidity (G). **(08 Marks)**

Module-2

3 a. Derive the expression for normal stress and shear stress on a plane inclined at 'θ' to the vertical axis in a general stress system as shown in Fig.Q3(a). **(08 Marks)**

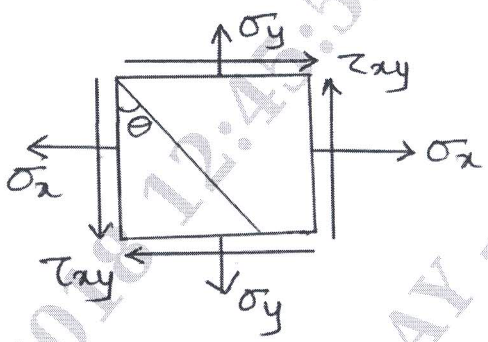

Fig.Q3(a)

b. A point in a strained member is subjected to biaxial stresses 85MPa (tensile) and 60MPa (compressive). The point is also subjected to a shear stress 45MPa such that shear force on vertical faces gives rise to clockwise couple. Determine :

i) stresses acting on a plane whose normal is at an angle of 40° with reference to 85MPa stress direction.

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

iii) Orientations of the principal planes and maximum and minimum shear stress planes. Compare analytical results with Mohr's circle results. **(12 Marks)**

OR

4 a. What are thin and thick cylinders? Explain with example. **(04 Marks)**

b. Derive Lame's equation for thick cylinders. **(08 Marks)**

c. A 0.9m long thin cylindrical shell has 450mm inner diameter and 12mm thickness. The cylinder is initially filled with water at atmospheric pressure. Determine the pressure at which an additional water of $187 \times 10^3 mm^3$ may be pumped into cylinder,

i) Ignoring the compressibility of water

ii) Considering the compressibility of water.

Take E = 200GPa, γ = 0.3 and K = 2.1×10^3 N/mm^2. **(08 Marks)**

Module-3

5 a. Explain the terms :

i) Sagging bending moment

ii) Hogging bending moment

iii) Point of contra flexure. **(03 Marks)**

b. Establish relationship between distributed load, shear force and bending moment with usual notations. **(03 Marks)**

c. Draw the shear force and bending moment diagram for the beam shown Fig.Q5(c). Find the location of point of contraflexure and magnitude of maximum bending moment. **(14 Marks)**

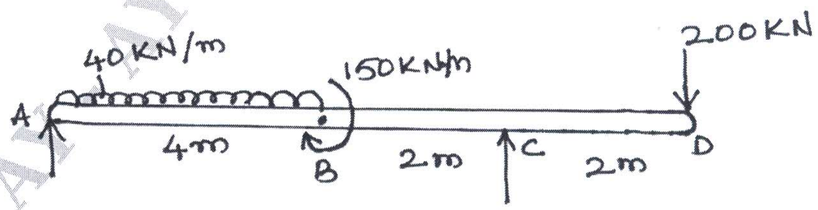

Fig.Q5(c)

OR

6 a. A cantilever has an I section with unequal flanges. The upper and lower flanges are (200mm × 14mm) and (100mm × 14mm) respectively. The web is (14mm × 250mm). The cantilever is subjected to UDL of magnitude 4 kN/m over its entire length of 3m and a point load W at the free end as shown in Fig.Q6(a). Yield stress for the material of beam is 330MPa. Taking the factor of safety as 2, determine the magnitude of maximum load W that can be applied. **(10 Marks)**

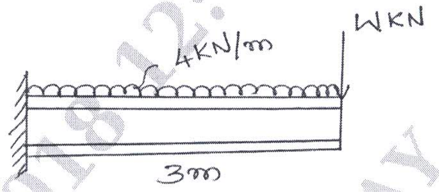

Fig.Q6(a)

b. Derive an expression with usual notations for the maximum deflection in a simply supported beam subjected to point load (W) at mid span. **(10 Marks)**

Module-4

7 a. Derive the torsion formula in the standard form $\frac{T}{J} = \frac{G\theta}{L} = \frac{\tau}{R}$ and list all the assumptions made while deriving the same. **(10 Marks)**

b. Compare the weight of solid shaft with that of a hollow one having same length to transmit a given power at a given speed if the material used for both the shafts is the same. The inside diameter of hollow shaft is 0.6 times the outer diameter. **(10 Marks)**

OR

8 a. Derive an expression for the critical load in a column subjected to compressive load, when one end is fixed and the other end is end free. **(10 Marks)**

b. A solid round bar of 60mm diameter and 2.5m is used as a strut. Find the safe compressive load for the strut if : i) Both ends are hinged ii) Both ends are fixed. Take $E = 2 \times 10^5 N/mm^2$ and factor of safety = 3. **(10 Marks)**

Module-5

9 a. Explain Castigliano's I and II theorems. **(08 Marks)**

b. Derive an expression for strain energy due to normal stress. **(06 Marks)**

c. Determine the strain energy of the prismatic beam AB as shown in Fig.Q9(c). Assume $I = 195.3 \times 10^3 mm^4$; $E = 2 \times 10^5$ MPa. **(06 Marks)**

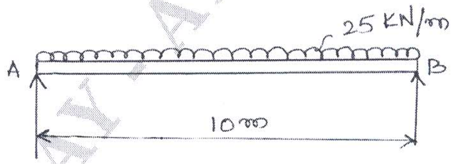

Fig.Q9(c)

OR

10 a. Write a note on : i) Maximum principal stress theory
ii) Maximum shear stress theory. **(10 Marks)**

b. A rod of circular section is to sustain a tensional moment of 300kN-m and bending moment 200kN-m. Selecting 45C8 steel (σ_{yt} = 353MPa) 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)**