CBCS SCHEME

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18ME32

Third Semester B.E. Degree Examination, June/July 2025
Mechanics of Materials

Time: 3 hrs. Max. Marks: 100

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

Module-1

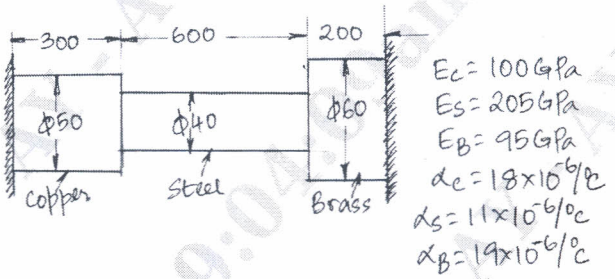
1 a. Draw the stress-strain diagrams for mild steel and cast iron and label the salient points. **(04 Marks)**

b. A tapered rod of length 'L' having a circular cross-section with diameters 'd_1' and 'd_2' at larger and smaller ends is subjected to a tensile load 'P'. Find the extension of the bar. **(08 Marks)**

c. A steel rod 50 mm diameter, 1000 mm long is coaxially enclosed in a brass tube of 60 mm external diameter, 4 mm thickness and 1000 mm length. Determine the stress induced in each material and the change in length if the assembly is subjected to an axial compressive force of 100 kN. Assume, E_{steel} = 200 GPa and E_{brass} = 100 GPa. **(08 Marks)**

OR

2 a. A composite bar made up of copper, steel and brass is rigidly attached to the end supports as shown in Fig.Q.2(a). Determine the stresses in the three portions of the bar when the temperature of the composite is raised by 70°C if i) the supports are rigid ii) the supports yield by 0.6 mm.



All dimensions in mm

Fig.Q.2(a)

(08 Marks)

b. Obtain an expression relating Young's modulus, shear modulus and Poisson's ratio. **(06 Marks)**

c. In the Fig.Q.2(c), aluminum tube is 0.2 mm longer than the steel rod. The axial load applied is 48 kN. Compute the load shared by the tube and rod. Assume E_{steel} = 210 GPa and $E_{Aluminium}$ = 70 GPa.

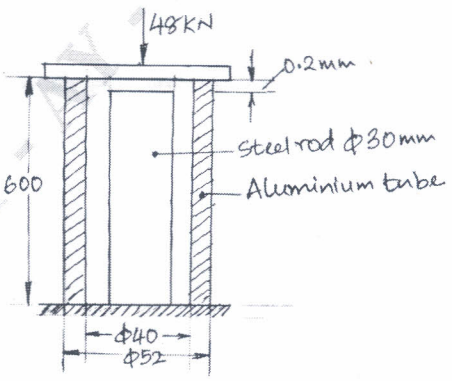


Fig.Q.2(c)

All dimensions in mm

(06 Marks)

Module-2

3 a. The intensity of resultant stress on a plane AB at a point, in a material under stress (Fig.Q.3(a)) is 80 N/mm^2 and is inclined at 30° to the normal to that plane. The normal components of stress on another plane BC at right angles to the plane AB is 60 N/mm^2. Determine:

i) The resultant stress on plane BC
ii) The principal stresses and their directions
iii) Maximum shear stresses and their planes
iv) With the help of a neat sketch show the angular positions of planes and corresponding stresses. **(12 Marks)**

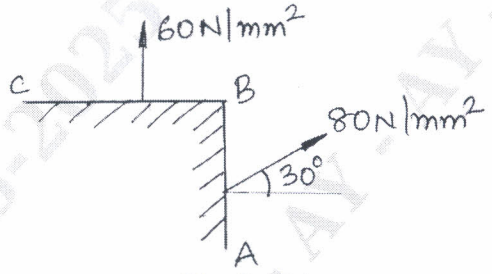


Fig.Q.3(a)

b. At a point in a machine component the stresses are 150 MPa and 50 MPa both tensile. Find by Mohr's circle method, the intensities of normal, shear and resultant stresses on a plane inclined at an angle of 55° with the axis of major tensile stress. Also determine the maximum shear stress in the component. **(08 Marks)**

OR

4 a. Derive the expressions for the radial pressure and the hoop stress (Lame's equations) and sketch the pressure and stress distribution across the cylinder wall. **(12 Marks)**

b. A closed cylindrical vessel made of steel plates 4 mm thick plane ends, carries a fluid under a pressure of 3 N/mm^2. The diameter of cylinder is 220 mm and the length is 750 mm. Calculate the longitudinal and hoop stresses in the cylinder wall and determine the change in diameter, length and volume of the cylinder. Assume, E = 2.0 x 10^5 N/mm^2 and μ = 0.28. **(08 Marks)**

Module-3

5 A horizontal beam 10 m long carries a UDL of 180 N/m and in addition to this a concentrated load of 200 N at the left end. The beam is supported at two points 7 m apart so chosen that each support carries half the total load. Draw the SFD and BMD for the beam. Also indicate the points of contra flexure if any. Refer Fig.Q.5.

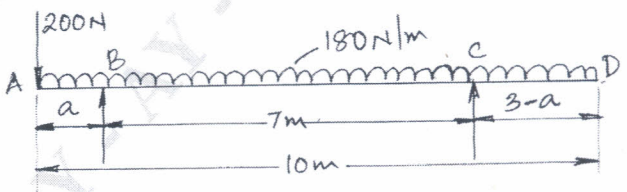


Fig.Q.5

(20 Marks)

OR

6 a. A cast iron beam has an I-section with top flange 160 mm × 20 mm, web 110 mm × 40 mm and bottom flange 80 mm × 20 mm. The beam is used as a cantilever of span 4 m and carries a UDL of 2 kN/m over the entire length. Calculate the maximum tensile and compressive stresses developed. **(12 Marks)**

b. Obtain an expression for the max shear stress developed in a solid circular section. **(08 Marks)**

Module-4

7 a. The load on a bolt consists of an axial pull of 10 kN together with a transverse shear force of 5 kN. Find the diameter of bolt required according to i) Maximum principal stress theory ii) Maximum shear stress theory. Take permissible tensile stress at elastic limit as 100 MPa. **(08 Marks)**

b. A MS shaft 60 mm in diameter is subjected to a bending moment of 25×10^5 N-mm and a torsional moment 'T'. If the yield point of steel in tension is 230 N/mm^2, find the value of this torque without causing yielding of the shaft according to i) Maximum normal stress theory ii) Maximum shear stress theory. Assume FOS = 1.5. **(12 Marks)**

OR

8 a. Calculate the diameter of a solid shaft transmitting 90 KW at 60 rpm if the shear stress in the shaft is limited to 60 MPa. Find also the length of shaft if the twist must not exceed 1° over the entire length. Assume $G = 8 \times 10^4$ N/mm^2. **(08 Marks)**

b. A solid shaft has 50 mm diameter. Determine the inner and outer diameters of a hollow shaft such that its area of cross section is same as that of solid shaft. The inner diameter of hollow shaft is 0.8 times its outer diameter. Compare the torsional strengths and torsional stiffness of solid shaft and hollow shaft. Length and material are same in both cases. **(12 Marks)**

Module-5

9 a. Derive an expression for the Euler's crippling load for a column with one end fixed and the other free. **(10 Marks)**

b. A column 3.5 m long has an I-section consisting of two equal flanges of 120 mm × 10 mm and a web of 10 mm × 120 mm. Material of the column is mild steel with σ_c = 320 MPa, E = 200 GPa and a = 1/7500. Both ends of the column are hinged. Compare the buckling loads obtained by Euler's formula and Rankine's formula. **(10 Marks)**

OR

10 a. Derive the expressions for the strain energy under following cases:
i) Strain energy due to axial load when the load is applied gradually.
ii) Due to shear. **(12 Marks)**

b. Using Castigliano's theorem obtain an expression for deflection of a simply supported beam AB subjected to a point load (single) at a distance 'a' from end A and 'b' from end B.

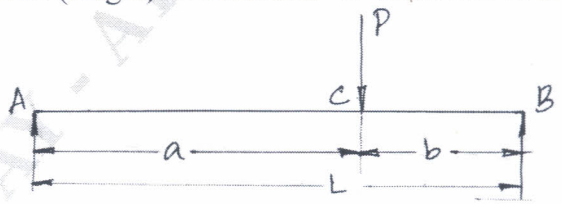


Fig.Q.10(b)

(08 Marks)

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