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Question Paper Code : 40355

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2025.

Third/Fourth Semester

Aeronautical Engineering

CE 8395 – STRENGTH OF MATERIALS FOR MECHANICAL ENGINEERS

(Common to: Aerospace Engineering/Automobile Engineering/Industrial Engineering/Industrial Engineering and Management/Manufacturing Engineering/Marine Engineering/Material Science and Engineering/Mechanical Engineering/Mechanical Engineering (Sandwich)/Mechanical and Automation Engineering/Mechatronics Engineering/Production Engineering/Robotics and Automation/Safety and Fire Engineering)

(Regulations 2017)

Time : Three hours

Maximum : 100 marks

(Note : Assume suitable data if needed)

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Draw the engineering stress-strain diagram for a mild steel and specify all the points.
2. If Young's modulus and the Poisson's ratio of material are 203 GPa and 0.28 respectively. Find the rigidity modulus and bulk modulus.
3. What are statically determinate beams? Give two examples.
4. Define the term 'shear centre'.
5. Specify the significance of the polar moment of inertia of a shaft subjected to torsion.
6. Two parallel springs of each stiffness 10 kN/m are connected in series with another spring of stiffness 5 kN/m. Find the stiffness of the equivalent system.
7. Write the expression for deflection, slope at free end of a cantilever beam subjected to a point load at the free end.
8. State the Maxwell's reciprocal theorem.

9. A thin spherical vessel of diameter 50 mm is subjected to an internal pressure of 2 MPa. Find the principal stresses.
10. State the assumptions of thick cylinders based on Lamé's theory.

PART B — ($5 \times 13 = 65$ marks)

11. (a) A circular steel bar having three segments is subjected to various forces at different cross-sections as shown in Fig. 11 (a). Determine the necessary force to be applied in Section C for the equilibrium of the bar. Also, find the total elongation of the bar. Take $E = 202$ GPa

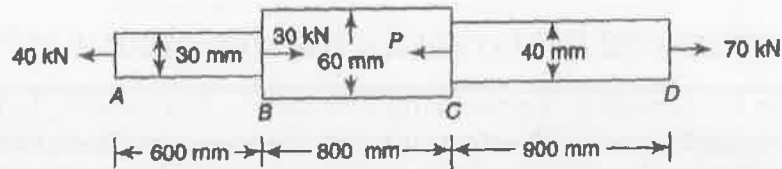


Fig. 11 (a)

Or

- (b) The stresses on two perpendicular planes through a point in a body are 30 MPa and 15 MPa both tensile along with a shear stress of 25 MPa. Find the magnitude and direction of principal stresses, the planes maximum shear stress and the normal and shear stresses on the planes of maximum shearing stress. Use either of analytical approach or Mohr's circle.
12. (a) A over hanging beam of 7 m span with overhangs rests on supports which are 4 m apart. The left end overhanging is 2 m. The beam carries loads of 30 kN and 20 kN on the left and the right ends respectively, apart from a uniformly distributed load of 25 kN/m between the supporting points. Draw the shear force and bending moment diagrams. Also, find the point of contra flexure.

Or

- (b) (i) A square beam 20 mm $\times$ 20 mm in section and 2 m long is supported at the ends. The beam fails when a point load of 400 N is applied at the centre of the beam. What uniformly distributed load per metre length will break a cantilever of the same material 40 mm wide, 60 mm deep and 3 m long? (8)
- (ii) A simply supported beam of a 2 m span carries a uniformly distributed load of 140 kN/m over the whole span. The cross-section of the beam is a T-section with a flange width of 120 mm, web and flange thickness of 20 mm and overall depth of 160 mm. Determine the shear stress in the flange at the junction of the flange and the web. (5)

13. (a) A solid cylindrical shaft is to transmit 75 kW power at 240 rpm. If the shear stress is not to exceed 50 MPa, find its diameter. What percentage saving in weight would be obtained if this shaft is replaced by a hollow one whose internal diameter is $\frac{2}{3}$ times the external diameter, the length, the material and maximum shear stress being the same?

Or

- (b) The stiffness of a close-coiled helical spring is 1.5 N/mm of compression under a maximum load of 60 N. The Maximum shear stress produced in the wire of the spring is 125 MPa. The solid length of the spring (when the coils are touching) is given as 50 mm. Find, the diameter of the wire, mean diameter of the coils and number of coils required. Take $C = 4.5 \times 10^4 \text{ Nmm}^2$.
14. (a) Derive the equation for the maximum deflection and slope at the supports of a simply supported beam carrying a uniformly distributed load throughout its span, using Macaulay's method.

Or

- (b) A cantilever beam of 2 m span carries two point loads each of 20 kN at 1 m and at 2 m from the fixed end. Determine the deflection of the beam at the free end using the moment area method. $E = 10^5 \text{ N/mm}^2$ and $I = 10^8 \text{ mm}^4$.
15. (a) A cylindrical thin drum 800 mm in diameter and 3 m long has a shell thickness of 10 mm. If the drum is subjected to an internal pressure of 2.5 MPa, determine the change in diameter, the change in length and the volume change. Also, find the volumetric strain. Take $E = 2 \times 10^5 \text{ N/mm}^2$. Poisson's ratio = 0.25.

Or

- (b) Determine the ratio of thickness to inner diameter of a tube subjected to internal pressure, if the ratio of the internal pressure to the maximum circumferential stress is 0.5. For such a tube of 250 mm inside diameter, find the alteration of thickness of metal, when the internal pressure is 80 MPa. Take $E = 205 \text{ GPa}$.

PART C — (1 × 15 = 15 marks)

16. (a) A steel rod of 16 mm diameter and 3 m length passes through a copper tube of 50 mm external and 40 mm internal diameter and of the same length. The tube is closed at each end with the help of 30 mm thick steel plates which are tightened by nuts till the length of the copper tube is reduced by 0.6 mm. The temperature of the whole assembly is then raised by 56°C. Determine the stresses in the steel and copper before and after the rise of temperature. Assume that the thickness of the steel plates at the ends does not change during tightening of the nuts. $E_{\text{steel}} = 210 \text{ GPa}$, $E_{\text{copper}} = 100 \text{ GPa}$, $\alpha_{\text{steel}} = 12 \times 10^{-6}/^{\circ}\text{C}$ and $\alpha_{\text{steel}} = 17 \times 10^{-6}/^{\circ}\text{C}$. Refer Fig. 16(a)

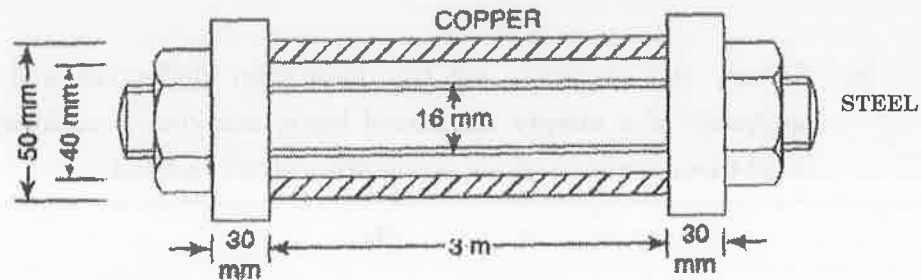


Fig. 16(a)
Or

- (b) A stepped shaft fixed at the two ends as shown in Fig. 16(b) is subjected to a torque of 300 N.m at Section C. The larger section is of aluminum and the smaller one is of steel. Determine the maximum stresses in the two materials. $G_s = 82 \text{ GPa}$ and $G_a = 27 \text{ GPa}$.

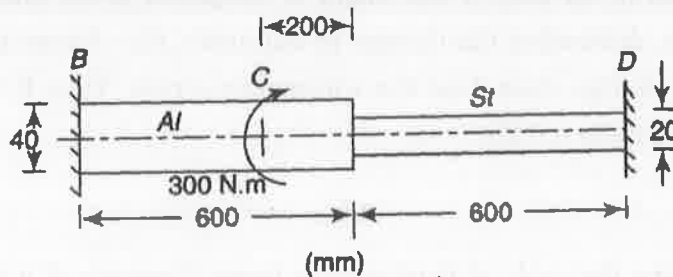


Fig. 16(b)