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R 3010

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2007.

Third Semester

Aeronautical Engineering

AE 1202 — SOLID MECHANICS

(Regulation 2004)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Determine the Poisson's ratio and bulk modulus a material, for which Young's modulus is 1.2×10^5 N/mm^2 and modulus of rigidity is 0.48×10^5 N/mm^2.

2. Define a composite bar. How will you find the stresses and load carried by each member of a composite bar?

3. Define the terms : Shear force, Bending moment.

4. What are the assumptions made in the theory of simple bending?

5. Draw a conjugate beam for a simply supported beam with a central point load 'W'

6. A cantilever of length 3 m is carrying a point load of 30 kN at a distance of 2 m from the fixed end? If I = 10^8 mm^4 and E = 2×10^5 N/mm^2, find the slope at the free end.

7. Define the term 'Polar modulus'. Find the expressions for polar modulus for a solid shaft and for a hollow shaft.

8. A closely coiled helical spring is to carry a load of 400 N. Its mean coil diameter is to be 10 times that of the wire diameter. Calculate these diameters if the maximum shear stress in the material of the spring is to be 80 N/mm^2.

9. Show that in a thin cylindrical shell subjected to internal fluid pressure, the circumferential stress is twice the longitudinal stress.

10. Write a note on Mohr's circle of stresses.

PART B — ($5 \times 16 = 80$ marks)

11. (a) (i) A steel tube 30 mm external diameter and 25 mm internal diameter encloses a gun metal rod 20 mm diameter to which it is rigidly joined at each end. The temperature of the whole assembly is raised to 140°C and the nuts on the rod are then screwed lightly home on the ends of the tube. Find the intensity of stress in the rod when the common temperature has fallen to 20°C. The Young's modulus for steel and gun metal may be taken as 2.1×10^5 N/mm^2 and 1×10^5 N/mm^2 respectively. The linear coefficient of expansion for steel and gun metal is 12×10^{-6} per°C and 20×10^{-6} per°C respectively. (10)

(ii) A bar of cross section 8 mm × 8 mm is subjected to an axial pull of 6 kN. The lateral dimension of the bar is changed to 7.9975 mm × 7.9975 mm. If the modulus of rigidity of the material is 9×10^5 N/mm^2, determine the Poisson's ratio and modulus of elasticity. (6)

Or

(b) (i) An unknown weight falls, through a height of 10 mm on a collar rigidly attached to the lower end of a vertical bar 600 cm long and 500 mm^2 in section. If the maximum extension of the rod is to be 3 mm, what is the corresponding stress and magnitude of the unknown weight? Take E = 2×10^5 N/mm^2. (9)

(ii) Derive an expression for the change in length of a bar hanging freely under its own weight. (7)

12. (a) A beam ABCDEF is 17 m long and it is supported at B and E which are 12 m apart. The left overhang AB is 3 m and the right overhang EF is 2 m. It carries two point loads, one of 20 kN at A and another of 24 kN at C, where BC is 3 m, in addition there is an UDL of 6 kN/m from D to F, D being 6 m to the left of E. Draw the shear force and bending moment diagrams. Also locate the points of contraflexure. (16)

Or

(b) A cast iron bracket subject to bending has the cross section of I form with unequal flanges. The overall dimensions of the I section are 200 mm × 300 mm × 150 mm. The thickness of the flange and web is same and equal to 50 mm. Find the position of the neutral axis and moment of inertia of the section about the neutral axis. If the maximum bending moment on the section is 40 MNmm, determine the maximum bending stress and its nature. (16)

13. (a) An overhanging beam ABC of span 9 m, the distance between the supports A and B being 6 m, carries a point load of 10 kN at its end C using Macaulay's method. Find the slope over each support and at the right end. Find also the maximum upward deflection between the supports and the deflection at the right end.

Take $E = 2 \times 10^5$ N/mm^2 and $I = 5 \times 10^8$ mm^4. (16)

Or

(b) A beam AB of 7 m span is simply supported at the ends A and B, carries a point load of 25 kN at C i.e. at 2 m from the left support A and an UDL of 8 kN/m over a span of 3.5 m from the right support B. Using Double Integration method, determine :

(i) Deflection at C and D

(ii) Position and magnitude of maximum deflection

(iii) Slope at the end A.

Take $E = 210 \times 10^6$ kN/m^2, $I = 25 \times 10^{-6}$m^4. (16)

14. (a) A hollow shaft having an internal diameter 50% of its external diameter transmits 500 kW at 150 rpm. Determine the external and internal diameter of the shaft if the shear stress is not to exceed 65 N/mm^2 and the twist in a length of 3 m should not exceed 1.4 degrees. Assume maximum torque = 1.2 Mean Torque and modulus of rigidity = 1×10^5 N/mm^2. (16)

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 N/mm^2. The solid length of the spring when the coils are touching is given as 5 cm. Find the diameter of wire, mean diameter of the coils and number of coils required. Take $C = 4.5 \times 10^4$ N/mm^2. (16)

15. (a) An elemental cube is subjected to tensile stresses of 80 N/mm^2 and 40 N/mm^2 acting on two mutually perpendicular planes and shear stress of 50 N/mm^2 on these planes. Using Mohr's circle method, determine the normal, tangential and resultant stresses in magnitude and direction on a plane inclined at 60° to the axis of the major principal stress. Also find the direction and magnitude of each of the principal stresses and the greatest shear stress. Check the answer analytically. (16)

Or

(b) Derive an expression for the change in volume of a thin cylindrical shell subjected to internal fluid pressure. (16)