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Question Paper Code : 20029

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2023.

Third Semester

Aeronautical Engineering

AE 3352 — SOLID MECHANICS

(Common to : Aerospace Engineering)

(Regulations 2021)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define equivalent system of forces.
2. Write the condition of equilibrium for a rigid body in space.
3. Write the relationship between shear force and bending moment.
4. Locate the centre of gravity of Triangle and Semicircle.
5. Compare elasticity and Plasticity.
6. Define Poisson's Ratio.
7. State the assumptions made in theory of simple bending.
8. Why hollow circular shafts are preferred when compared to solid circular shafts?
9. Define principal stresses and principal planes.
10. State the limitation of Euler's formula.

PART B — (5 × 13 = 65 marks)

11. (a) (i) A gusset plate of roof truss is subjected to forces as shown in Fig.11(a)(i). Determine the magnitude of the resultant force and its orientation measured counter clockwise from the positive x-axis. (7)

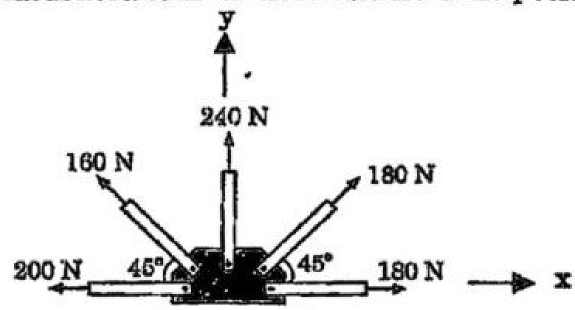

Fig.11 (a)(i)

(ii) Describe the classification system of forces with suitable examples. (6)

Or

(b) (i) A beam ABCDE hinged at A and supported on rollers at D, is loaded as shown in Fig.11(b)(i). Find the reactions at A and D. (7)

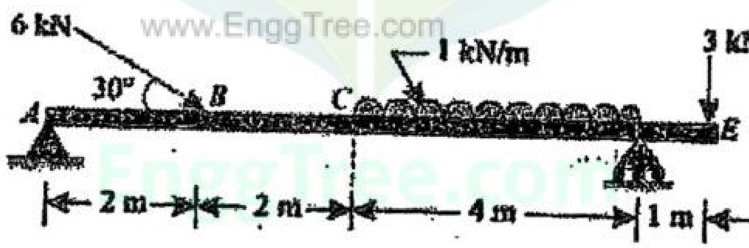

Fig.11 (b)(i)

(ii) Explain the concept of free body diagram and explain its importance. (6)

12. (a) (i) A simply supported beam 6 m long is carrying a uniformly distributed load of 5 kN/m over a length of 3 m from the right end. Draw shear force and bending moment diagrams for the beam and also calculate the maximum bending moment on the beam. (7)

(ii) A timber cantilever beam is 3m long. It is loaded with a u.d.l of 3kN/m over the entire length of the cantilever, Draw shear force and bending moment diagrams for the beam. (6)

Or

(b) (i) Find the moment of Inertia about the Centroidal axis XX as shown in Fig.12(b)(i). (7)

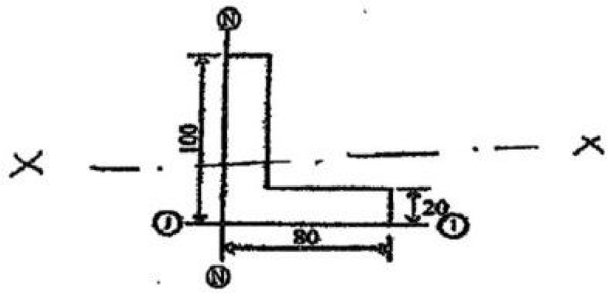

Fig.12 (b)(i)

(ii) Find the centroid of I section
Top flange 100 mm × 20 mm
Web 20 mm × 100 mm
Bottom flange 200 mm × 20 mm. (6)

13. (a) (i) Two vertical rods one of steel and other of copper are rigidly fixed at the top and 80 cm apart. Diameter and length of each rod are 3 cm and 3.5 m respectively. A cross bar fixed to the rods at lower ends carries a load of 6 kN such that the cross bar remains horizontal even after loading. Find the stress in each rod and position of load on the bar. Take E for steel as 2×10^5 N/mm² and for copper as 1×10^5 N/mm². (7)

(ii) A rod is 2m long at 10°C. Find the expansion of the rod when the temperature is raised to 80°C. If the expansion is prevented find the stress in the material. Take E = 1 × 105 MPa and $\alpha = 0.000012$/°C. (6)

Or

(b) (i) A circular rod of steel is 20 mm in diameter and 500 mm long it is subjected to an axial pull of 45KN. If E = 2000×10^3 N/mm². Find stress, linear strain, change in length and change in volume of the bar. (7)

(ii) A material has modulus of elasticity 1.1×10^5 MPa and modulus of rigidity 0.4×10^5 MPa. Find bulk modulus and Poisson's ratio. (6)

14. (a) (i) Derive the torsion equation for a circular shaft of diameter 'd' subjected to torque 'T'. (7)

(ii) Find the torque that can be transmitted by a thin tube 6 cm mean diameter and wall thickness 1 mm. the permissible shear stress is 6000 N/cm². (6)

Or

(b) (i) A 100 mm × 200 mm rolled steel I section has the flanges 12 mm thick and web 10 mm thick. Find (7)

(1) The safe udl the section can carry over a span of 6m if the permissible stress is limited to 150 N/mm^2

(2) The maximum bending stress when the beam carries a central point load of 20 kN.

(ii) An I section beam 350 mm × 150 mm has a web thickness of 10 mm and a flange thickness of 20 mm. If the shear force acting on the section is 40 kN, find the maximum shear stress developed in the I-section. (6)

15. (a) (i) A cylindrical shell 3m long which is closed at the ends, has an internal diameter of 1 m and a wall thickness of 25 mm. Calculate the circumferential and longitudinal stresses induced and also changes in the dimensions of the shell, if it is subjected to an internal pressure of 2 N/mm^2. Take $E = 2 \times 10^5$ N/mm^2 and $1/m = 0.3$. (7)

(ii) Derive the formula for longitudinal and circumferential stresses of a spherical shell. (6)

Or

(b) (i) State the Euler's assumption in column theory and derive a relation for the Euler's crippling load for a column with both ends fixed. (7)

(ii) The principal stresses in the wall of a container are 40 MN/m^2 and 80 MN/m^2. Determine the normal, shear and resultant stresses in magnitude and direction in a plane, the normal of which makes an angle of 30° with the direction of maximum principal stress. (6)

PART C — (1 × 15 = 15 marks)

16. (a) A beam of length 8 m is simply supported at its ends and carries two-point loads of 36 KN and 46 KN at a distance of 1.5 m and 4 m from the left support. Find: (15)

(i) Deflection under each load.

(ii) Maximum deflection and

(iii) The point at which maximum deflection occurs, given $E = 2 \times 10^5$ N/mm^2 and $I = 85 \times 10^6$ mm^4.

Or

(b) An I section of 240 mm × 12 mm thick web and 120 mm × 20 mm flanges is 6 m long and used as a column with both ends fixed. Calculate the buckling load for the column using (15)

(i) Rankine's formula, take yield stress $\sigma_c = 550$ N/mm^2 and a = 1/1600

(ii) Euler's formula, Young's modulus is 200 GPa.