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B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2025

Fourth Semester

Mechanical Engineering

CE 3491 – STRENGTH OF MATERIALS

(Common to Mechanical Engineering (Sandwich)/Safety and Fire Engineering)

(Regulations 2021)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Mention the cause of strain in a body.
2. Define Principal Planes.
3. Classify beams with suitable sketches.
4. Define Flitched beams.
5. List any four assumptions made in the theory of torsion.
6. Differentiate closed and open coiled helical springs.
7. Write the maximum deflection under an eccentric point load in a simply supported beam.
8. Introduce the theorems used in conjugate beam method.
9. Mention Lame's equations.
10. Enlist the streses in a thin cylinder.

PART B — (5 × 13 = 65 marks)

11. (a) A beam weighing 450 N is held in a horizontal position by three vertical wires, one attached to each end of the beam, one to the middle of its length. The outer wires are of brass of diameter 1.25 mm and the central wire is of diameter 0.625 mm. If the beam is rigid and wires of the same length and unstressed before the beam is attached, estimate the stresses induced in the wires. Take Young's modulus for brass 86 GN/m^2 and for steel 210 GN/m^2

Or

(b) A brass bar having a cross-sectional area of 1000 mm² is subjected to axial forces as shown in Fig. 1. Find the total change in length of the bar. Take E = 105 GN/m².

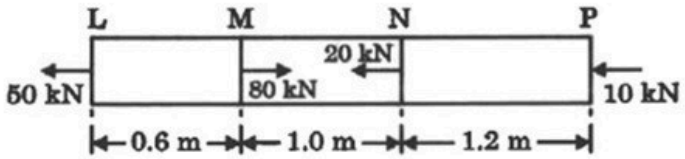

Fig.1

12. (a) A beam ABCD 10 m long is supported at B and C. The overhangs AB and CD are 2 m and 3 m respectively. The overloading AB carries udl of 1 kN/m and CD carries udl of 0.5 kN/m. In addition, there are point loads of 1 kN, 2 kN and 1 kN, at distances of 1.5 m, 3 m and 8 m from A respectively. Find the reactions and draw shear force and bending moment diagrams.

Or

(b) A cantilever PQRS, 7 m long is fixed at P such that PQ = QR = 2 m and RS = 3 m. It carries loads of 5 kN, 3 kN and 2 kN at Q, R and S respectively in addition to udl of 1 kN/m run between P and Q and 2 kN/m run between R and S. Determine the reactions and plot shear force and bending moment diagrams.

13. (a) A solid steel shaft has to transmit 75 kW at 200 rpm. Taking allowable shear stress as 70 MN/m², find the suitable diameter of the shaft, if the maximum torque transmitted on each revolution exceeds the mean by 30%.

Or

(b) A composite spring has two close-coiled springs connected in series: one spring has 12 coils of a mean diameter of 25 mm and wire diameter of 2.5 mm. Find the wire diameter of the other spring, if it has 15 coils of mean diameter 40 mm. The stiffness of the composite spring is 1.5 kN/m. Determine the greatest load that can be carried by the composite spring and the corresponding extension if maximum stress is 250 MN/m². Take C = 800 N/m².

14. (a) A cantilever beam of 1.5 m length carries two point loads of 4 kN each at the free end and at 0.6 m from the free end. Using area moment theorem compute the slope and deflection at the free end. Take E=200 kN/mm² and I = 3.221×10^6 mm⁴.

Or

(b) A beam is 10 m long and is simply supported at the ends. It carries concentrated loads of 100 kN and 60 kN at distances of 2 m and 5 m respectively from the left end. Using Macaulay's method, calculate the deflection under each load and the maximum deflection in the beam. Take $I = 18 \times 10^8 mm^4$ and $E = 200\ kN/mm^2$.

15. (a) The ends of a thin cylinder, 180 mm internal diameter and wall thickness 3mm are closed by rigid plates and it is then filled with a liquid. When an axial compressive force of 33.6 kN is applied to the cylinder, the pressure of the liquid rises by 72 kN/m^2. If $E = 210\ GN/m^2$ and Poisson's ratio = 0.3, find the Bulk modulus of the liquid.

Or

(b) A thick walled closed-end cylinder is made of an Al-alloy (E = 72 GPa, l/m=0.33), has inside diameter of 200 mm and outside diameter of 800 mm. The cylinder is subjected to internal fluid pressure of 150 MN/m^2. Determine the principal stresses and maximum shear stress at a point on the inside surface of the cylinder.

PART C — ($1 \times 15 = 15$ marks)

16. (a) The following data relate to a bar subjected to a tensile test:

Diameter of the bar, d = 30 mm

Tensile load, P = 54 kN

Gauge length = 300 mm

Extension of the bar = 0.112 mm

Change in diameter = 0.00366 mm

Calculate: (i) Poisson's ratio (ii) The values of three moduli.

Or

(b) Fig.2 shows a composite shaft. If 2kNm torque is applied at the junction determine the maximum shear stress developed in steel and copper shaft. Assume that $C_{steel} = 2C_{copper}$.

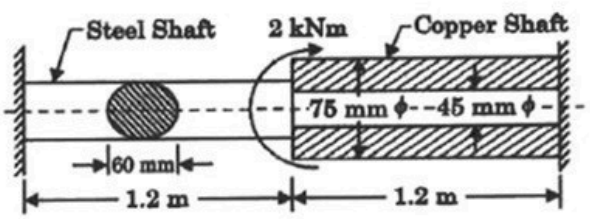

Fig. 2