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Question Paper Code : 82343

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 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 — ($10 \times 2 = 20$ marks)

1. Distinguish between rigid bodies and deformable bodies.
2. Write the relationship between elastic constants.
3. What is meant by neutral layer and neutral axis in the beam?
4. What are flitched beams?
5. State the assumptions made in the theory of torsion.
6. Differentiate between closed coil and open coil helical spring.
7. Draw the conjugate beam for a cantilever beam fixed at left end.
8. What is moment area method?
9. State Lamé's theory.
10. Differentiate thin cylinder and thick cylinder.

PART B — ($5 \times 13 = 65$ marks)

11. (a) A steel cube block with a side length of 50 mm is subjected to forces of 10 kN tensile, 12.5 kN compressive, and 7.5 kN tensile along three mutually perpendicular directions. Taking $E = 200$ GPa and Poisson's ratio = 0.3, determine the changes in the dimensions of the block and in its volume.

Or

- (b) A brass bar of 60 mm diameter and 0.50 m length is placed inside a steel tube with an internal diameter of 80 mm, an external diameter of 100 mm, and the same length. Both are connected together at their ends, and the composite bar is subjected to an axial compressive load.

Determine the maximum axial load that the composite bar can carry under the following conditions :

- The maximum stresses in brass and steel are limited to 30 MPa and 80 MPa, respectively.
 - The maximum compression in the steel tube is limited to 2 mm. Take $E_s = 200$ GPa and $E_B = 85$ GPa.
12. (a) Draw the shear force and bending moment diagrams for the beam as shown in Figure 1 and mark all salient values on them.

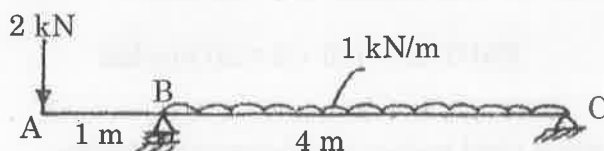


Figure. 1

Or

- (b) A simply supported beam with across-section of 50 mm $\times$ 50 mm and a length of 800 mm can carry a point load of 3 kN at its center. This beam is to be replaced by a cantilever beam made of the same material, with a cross-section of 50 mm $\times$ 100 mm and a length of 1.5 m. Determine the maximum point load that can be applied at the free end of the cantilever such that the maximum bending stress remains the same in both beams.
13. (a) A close-coiled helical spring is made of steel wire with a diameter of 6 mm and has 15 coils. The spring has a mean coil diameter of 100 mm and is subjected to an axial load W that produces a maximum shear stress of 100 MPa. Find the load, the deflection produced, the energy stored, length of the spring wire and the stiffness of the spring. Take the modulus of rigidity $C = 80$ GPa.

Or

- (b) A 3 m long solid shaft transmits 15 kW at 1200 rpm. Determine the required diameter of the shaft assuming that the maximum shear stress in the shaft is limited to 25 MPa and the angle of twist is not to exceed 5° . The mean torque is 75% of the maximum torque and $C = 80 \text{ GPa}$.
14. (a) A cantilever beam of total length 3 m is subjected to two concentrated loads, 20 kN at the free end and 10 kN at a point 1.5 m from the free end. The beam has a flexural rigidity of EI over the 1.5 m segment nearest the free end, and $2EI$ over the remaining 1.5 m segment toward the fixed support. Determine the slope and deflection at load points. Use area moment method.

Or

- (b) A simply supported beam of span 4 m is subjected to a uniformly distributed load of 24 kN/m over a length of 2 m from the left support A and a concentrated load of 24 kN located at 1 m from the right support B. Using Macaulay's method, determine
- (i) The slope at supports A and B (5)
 - (ii) Deflection at the end of uniform load and at the points of application of concentrated load. (4)
 - (iii) Location and magnitude of the maximum deflection. (4)
- EI is constant throughout.
15. (a) A copper tube 450 mm long, having 45 mm internal diameter and 1.5 mm thick walls is closed at its ends rigidly. The tube is subjected to an internal fluid pressure of 3 MPa and at the same time pulled in axial direction with a force of 3 kN. Compute
- (i) Change in the length
 - (ii) Change in internal diameter of the tube. Take $E = 100 \text{ GPa}$ and $\mu = 0.3$.

Or

- (b) A thick cylinder of internal diameter 100 mm, external diameter 150 mm is subjected to an internal and external pressure of 60 MPa and 20 MPa respectively. Determine the hoop stresses at inner and outer surfaces, Maximum shear stress and the change in internal volume. Length of the cylinder is 2 m. $E = 200 \text{ GPa}$ and $\mu = 0.3$.

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PART C — ($1 \times 15 = 15$ marks)

16. (a) A T beam having a flange of $150 \text{ mm} \times 20 \text{ mm}$ and a web of $20 \text{ mm} \times 160 \text{ mm}$ is simply supported over a span of 6 m and carries UDL of 5 kN/m along its entire span and concentrated load of 3.5 kN at mid-span.
- (i) Calculate the maximum bending stresses in the beam and sketch the distribution diagram.
 - (ii) Calculate the necessary shear stress values and sketch the shear stress distribution across the section where the shear force is maximum.

Or

- (b) At a point in an elastic material, a direct tensile stress of 70 MPa and a direct compressive stress of 50 MPa are applied on planes at right angles to each other. If the maximum principal stress is limited to 75 MPa , find the shear stress on the planes. Also find the other principal stress, the stresses on the plane of maximum shear and the stresses on a plane at 35° clockwise from the minor principal plane.