

Reg. No. : 

|  |  |  |  |  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|--|--|--|

|                                    |
|------------------------------------|
| <b>Question Paper Code : 12349</b> |
|------------------------------------|

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2026.

Fourth Semester

Mechanical Engineering

CE3491 — 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. Write the relationship between the four elastic constants.
2. What do you mean by principal strains?
3. What is meant by point of contraflexure? How is it located on a beam?
4. State the relationship between shear force and bending moment.
5. State the assumptions in the theory of torsion.
6. Distinguish between closed and open coil helical springs.
7. Sketch the conjugate beam for a simply supported beam.
8. State Mohr's theorem for slope and deflection.
9. Give two practical applications of thin and thick cylinders.
10. State the governing principles for a compound bar subjected to an axial load.

PART B — (5 × 13 = 65 marks)

11. (a) A compound tube consists of a steel tube 170mm internal diameter and 10mm thickness and an outer brass tube 190mm external diameter and 10mm thickness. The two tubes are of same length. The compound tube carries an axial load of 1500 kN. Find the stresses and the load carried by each tube and the amount by which it shortens. Length of each tube is 0.20 m. Take  $E_s = 200\text{GN/m}^2$  and  $E_b = 100\text{GN/m}^2$ .

Or

- (b) At a point in a strained material, the principal stresses are  $150\text{MN/m}^2$  (tensile) and  $50\text{MN/m}^2$  (compressive). Determine the magnitude and direction of a resultant stress on a plane inclined at  $60^\circ$  to the axis of major principal stress. Also find the resultant stress and maximum shear stress at the point.
12. (a) Draw the bending moment and shear force diagrams for the beam loaded as shown in figure 12(a). Determine the value of maximum bending moment and also locate the point of contra flexure in this loaded beam.

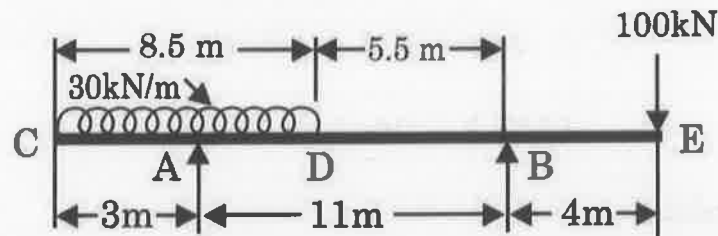


figure 12(a)

Or

- (b) A simply supported beam carries a uniformly distributed load of intensity 3 kN/m over the entire span of 6m. The cross section of the beam is a T-section having the following dimensions such as flange width = 125 mm; flange thickness = 25 mm ; Web depth = 175 mm; web thickness = 25mm. Over all depth of T-section = 200 mm.
- (i) Calculate the maximum shear stress for the section.
- (ii) Sketch the shear stress distribution across the section for the maximum shear force.
13. (a) A solid steel shaft 6m long is firmly fixed at each end. A torque of 1250 Nm is applied to the shaft at a section 2.4m from one end is shown in figure 13(a). Modulus of rigidity =  $84\text{GN/m}^2$

- (i) What are the fixing torques setups at the ends of the shaft?
- (ii) If the diameter of the shaft is 40mm, what are the maximum shear stresses in the two end portions?
- (iii) Calculate also the angle of twist for the section where the torque is applied?

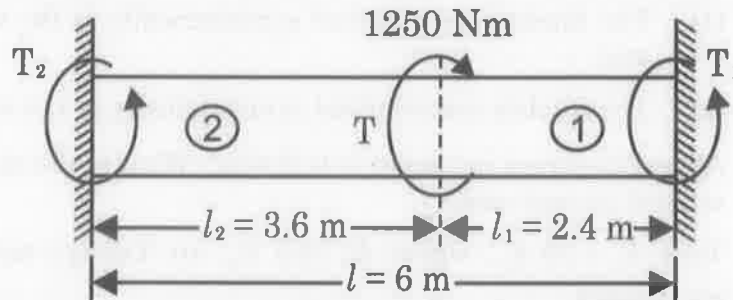


Figure 13(a)

Or

- (b) A closed coil helical spring is made out of 12mm diameter steel rod. The coil consists of 10 complete turns with a mean diameter of 120mm. The spring carries an axial pull of 250N. Find the maximum shear stress induced in the section of the rod. If  $C=80\text{ GN/m}^2$ , find the deflection, stiffness and strain energy stored in the spring.
14. (a) A simply supported beam of span 4m is subjected to a uniformly distributed load of 20kN/m for a length of 2m from the left support A and a concentrated load of 20kN at 1m from the right support B. Using Macaulay's method, determine the slope at supports A & B and deflection at the end of uniformly distributed load and at the points of application of concentrated load. Also determine the region where the deflection is maximum. EI is constant throughout.
- Or
- (b) A beam ABC is free at A and simply supported at B & C. The beam carries a concentrated load of 30kN at the free end A and a uniformly distributed load of 40kN/m over the length BC. Length AB=1m and length BC = 3m. The moment of inertia of the portion AB is I and that of portion BC is 2 I. Determine the slope and deflection at free end A. Use conjugate beam method.
15. (a) A thick cylinder of internal diameter 100mm and outer diameter 200mm is subjected to an internal pressure 60MPa. Determine the maximum and minimum hoop and shear stresses in the cylinder. Also determine the change in length of the cylinder. The length of the cylinder is 2m. Take  $E=200\text{GPa}$  and  $\mu = 0.25$ .

Or

- (b) A thin steel cylinder 900mm long, 150mm internal diameter is made from plates of 5mm thickness. It is subjected to an internal pressure of 7MPa. The increase in length due to the internal pressure is found to be 0.115mm. Taking  $E_s = 200\text{GPa}$ : determine the stresses developed and the changes in the internal diameter and the internal volume.

PART C — (1 × 15 = 15 marks)

16. (a) A timber beam 150mm wide and 200mm deep is to be reinforced by bolting on two steel flitches each 150mm × 10mm in section.

(i) Find the moment of resistance when: (8)

(1) The flitches are attached symmetrically at the top and bottom and

(2) The flitches are attached symmetrically at the sides

(ii) Allowable stress in timber is  $6 \text{ MN/m}^2$ . What is the maximum stress in steel in each case? (7)

Take  $E_s = 20 E_w$ , where  $E_s$  and  $E_w$  are Young's modulus for steel and timber.

Or

- (b) A cylinder of 100 mm inside and 150 mm outside diameter is to be reinforced by shrinking on a second tube of 200 mm outside diameter. The compound tube is to withstand an internal pressure of 60MPa. The shrinkage pressure developed at the common surface owing to shrinkage is 15MPa. Determine the variation of the hoop stress across the thickness of the compound cylinder. What will be the initial difference of diameters at the common surface before shrinking? Take  $E=200\text{GPa}$ .