RollNo. | | | | | | | | | | |

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. /B.Tech / B. Arch (Full Time) - END SEMESTER EXAMINATIONS, NOV / DEC 2024

B.E. INDUSTRIAL/ MANUFACTURING / MATERIALS SCIENCE/ MECHANICAL ENGINEERING /PRINTING AND PACKING TECHNOLOGY

Semester -III

**CE23C01 – MECHANICS OF MATERIALS**

(Regulation 2023)

Time:3hrs Max.Marks: 100

| | |
|---|---|
| CO1 | To develop the understanding of the principle concepts of stress, strain and deformation of solids for various engineering applications. |
| CO2 | To analyse the flexural and shear stresses induced in beams due to different loading conditions |
| CO3 | To analyse the effect of torsion on shafts and springs. |
| CO4 | To understand and analyse the deflection of beams for different support and loading conditions |
| CO5 | To examine the stresses induced in thin and thick shells. |

**BL – Bloom's Taxonomy Levels**

(L1-Remembering, L2-Understanding, L3-Applying, L4-Analysing, L5-Evaluating, L6-Creating)

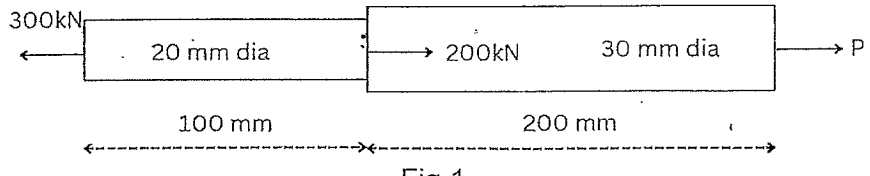
## PART- A(10x2=20Marks)

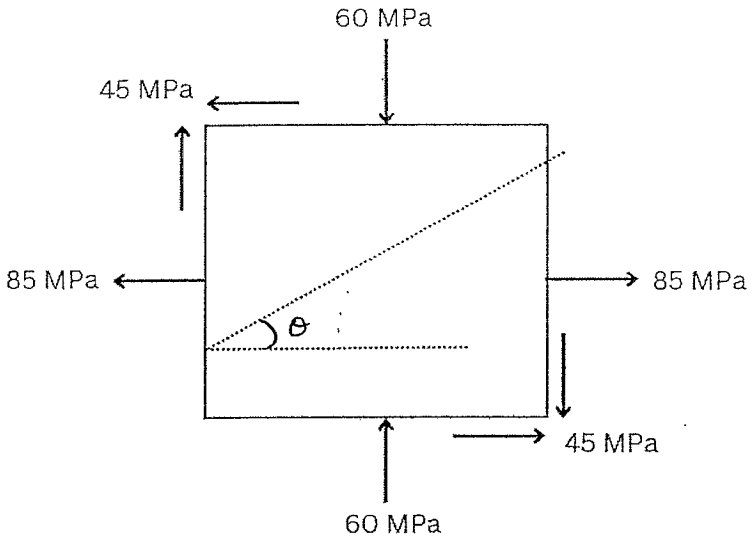
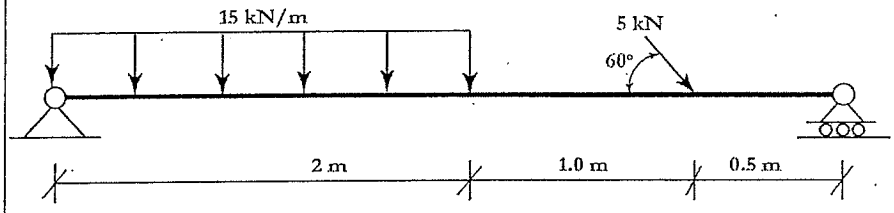
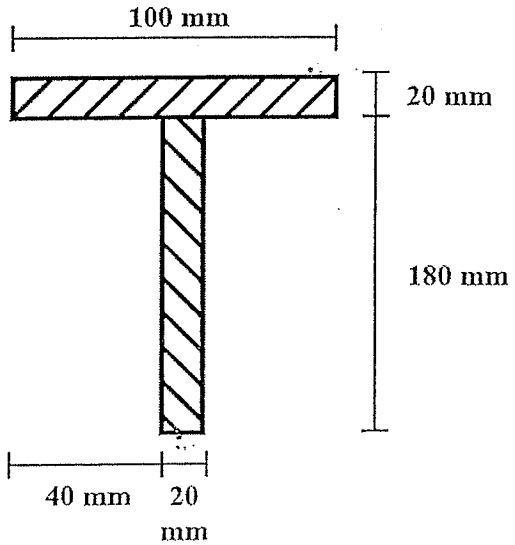
(Answer all Questions)

| Q.No. | Questions | Marks | CO | BL |
|---|---|---|---|---|
| 1 | Give the relationship between Bulk Modulus and Young's Modulus. | 2 | 1 | 1 |
| 2 | Define principal stresses and principal planes. | 2 | 1 | 1 |
| 3 | What is the maximum bending moment in a simply supported beam of span 'L' subjected to UDL of 'w' throughout the span? | 2 | 2 | 2 |
| 4 | Write the assumptions in the theory of simple bending. | 2 | 2 | 2 |
| 5 | Define polar modulus. | 2 | 3 | 1 |
| 6 | Define torsional rigidity. | 2 | 3 | 1 |
| 7 | Infer the theorem for conjugate beam method. | 2 | 4 | 2 |
| 8 | Give the slope and defection for a cantilever beam subjected to uniformly distributed load of 'w/unit run' for a length 'l'. | 2 | 4 | 1 |
| 9 | What are thick cylinders? | 2 | 5 | 2 |
| 10 | State maximum principal strain theory. | 2 | 5 | 1 |

## PART- B(5x 13=65Marks)

(Restrict to a maximum of 2 subdivisions)

| Q.No. | Questions | Marks | CO | BL |
|---|---|---|---|---|
| 11 (a) | Determine the stress in different segments of a circular bar as shown in Fig.1. Compute the total elongation of the bar, if E=200GPa.   Fig.1 | 13 | 1 | 3 |
| | OR | | | |

| | | | | |
|---|---|---|---|---|
| 11 (b) | For the state of stress shown in Fig.2, determine the principal stresses and locate principal planes. Also obtain maximum tangential stress and locate corresponding planes.<br>  <br><br>Fig. 2. | 13 | 1 | 3 |
| 12 (a) | Analyse the following beam as shown in Fig. 3 and draw the SFD and BMD.<br>  <br><br>Fig. 3 | 13 | 2 | 4 |
| | **OR** | | | |
| 12 (b) | The T-section beam (Fig. 4) is simply supported and subjected to a uniformly distributed load of 15 kN/m on the top flange over a span of 3 m. Calculate the stress distribution across the section for maximum bending moment and sketch the stress distribution at 50 mm interval depth through the section.<br>  <br><br>Fig. 4 | 13 | 2 | 4 |

| | | | | |
|---|---|---|---|---|
| 13 (a) | A solid steel shaft has to transmit 175kW at 200 rpm. Taking allowable shear stress as 90 N/mm$^2$. Determine the suitable diameter for the shaft. Also, determine the percentage saving in material if the solid shaft is replaced by a hollow shaft of inner (internal) diameter as 60% of outer (external) diameter. | 13 | 3 | 3 |
| | OR | | | |
| 13 (b) | A 14 m long horizontal shaft is securely fixed at each end. It is acted upon by two axial couples; one of 40 kN-m clockwise at a distance of 5 m and another of 50 kN-m counter-clockwise at a distance of 11 m from the left end. Find the end-fixing couples. What will be the diameter of the solid shaft for a maximum shear stress of 45 MPa? In what way will a line on the surface originally parallel to the axis appear after the application of the torque? Also find the position where the angular twist of the shaft is zero. | 13 | 3 | 3 |
| | | | | |
| 14 (a) | A beam AB of span 4 m is simply supported at its ends A (hinged) and B (roller). It carries a point load of 10 kN at a distance of 1 m (rightward) from the end A and a uniformly distributed load of 5 kN/m over the right half span (i.e., center to end B). Determine using Macaulay's method (i) the maximum deflection in the beam and (ii) slope at the ends. Take, EI = 10,000 kNm$^2$. | 13 | 4 | 3 |
| | OR | | | |
| 14 (b) | A cantilever beam of span 2 m has a uniform cross-sectional area (200 x 300 mm) and carries a concentrated load of 15 kN at the free end. Find the slope and deflection at a distance 1.5 m from the fixed end (or 0.5 m leftward from the free end) using the Moment-Area Method. Take, E as 2 x $10^5$ N/mm$^2$. | 13 | 4 | 3 |
| | | | | |
| 15 (a) | A thin cylindrical shell 1m in diameter and 3 m long has a metal wall of thickness 10 mm. It is subjected to an internal fluid pressure of 3 MPa. Find the circumferential and longitudinal stresses in the wall. Determine the changes in length, diameter, and volume of the cylinder. Also find the maximum shear stress in the cylinder. Assume E=210 GPa and μ=0.3. | 13 | 5 | 3 |
| | OR | | | |
| 15 (b) | Discuss the salient features of Von Mises Failure Theory with a neat illustration. | 13 | 5 | 3 |

## PART- C(1x 15=15Marks)

(Q.No.16 is compulsory)

| Q.No. | Questions | Marks | CO | BL |
|---|---|---|---|---|
| 16. | A simply supported beam of length 6 m carries two point loads each of 5 kN at a distance of 1 m from each end. If E = 2 × $10^5$ N/mm$^2$ and I = $10^8$ mm$^4$ for the beam, then using conjugate beam method determine<br>(i) Slope at each end and under each load<br>(ii) Maximum deflection | 15 | 4 | 5 |

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