QP Code:ME2T01-1 **(Pages: 4)**

Reg No : ..... Name : .....

MAR ATHANASIUS COLLEGE OF ENGINEERING, KOTHAMANGALAM

(Govt. Aided Autonomous Institution)

Third Semester B.Tech. Degree (SAY) Examination, February, 2026

Course Code: B24ME2T01

Course Name: MECHANICS OF SOLIDS

Max. Marks: 100 Duration:3 Hours

PART - A: 30 Marks (10 Qns x 3 Marks)

Answer all questions

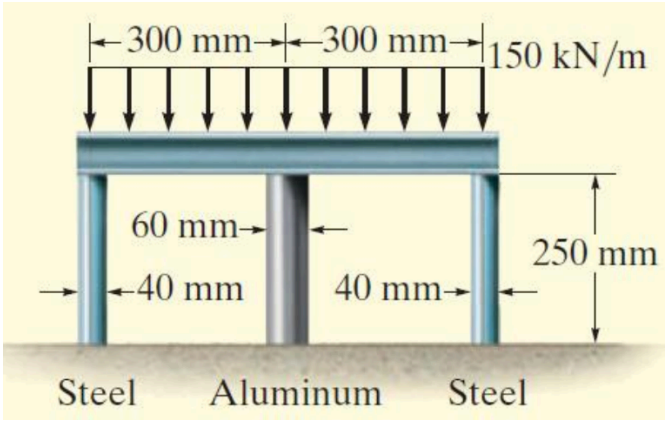
1. Define the terms stress and strain. What are the different types of stresses and strains?
2. Evaluate the volumetric strain of a rectangular bar whose dimensions are L x B x D.
3. How are shear stresses on perpendicular planes related according to the equality of cross shears?
4. Define plane stress problem. Give an example with neat figure.
5. Distinguish between crushing failure and buckling failure of columns.
6. Write the mathematical form of the torsional formula and explain its componets.
7. State the boundary conditions generally used in solving the differential equation of the elastic curve.
8. Explain the significance of flexural rigidity in beam bending.
9. Explain why strain energy is recoverable in elastic deformation but not in plastic deformation.
10. How are Haigh's theory of maximum strain energy and Von Mises' theory of maximum distortion energy related to each other?

PART - B: 70 Marks (5 Qns x 14 Marks)

Answer any One full question from each module.

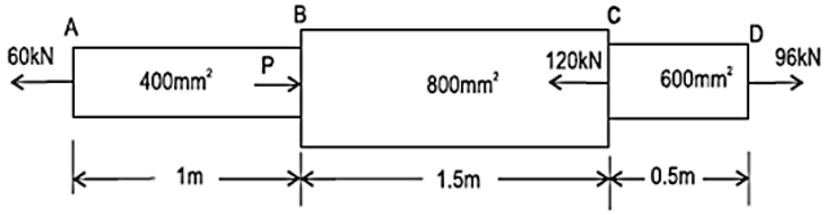
Module 1

11. The rigid beam shown in figure is fixed to the top of the three posts made of A-36 steel and 2014-T6 aluminium. The posts each have a length of 250 mm when no load is applied to the beam, and the temperature is T_1=20°C. Determine the force supported by each post if the bar is subjected to a uniformly distributed load of 150 kN/m and the temperature is raised to T_2 = 80°C.



OR

12. A steel bar ABCD of varying section is subjected to axial force as shown in the figure. Find the value of P necessary for equilibrium. Determine the total deformation of the bar. What will be the axial load that will produce the same strain if the bar is replaced by a bar of uniform cross-section with the same length and 20 mm diameter? Take E = 200 GPa.



Module 2

13. The state of stress at a point is given by the Cartesian stress tensor

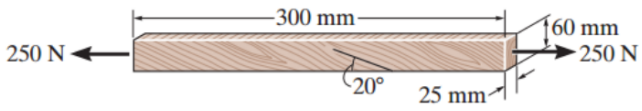
$$\sigma = \begin{pmatrix} 3 & -1 & 1 \\ -1 & 5 & -1 \\ 1 & -1 & 3 \end{pmatrix}$$

Find (i) the three stress invariants (ii) characteristic equation (iii) principal stresses (iv) unit normal of the maximum principal plane.

OR

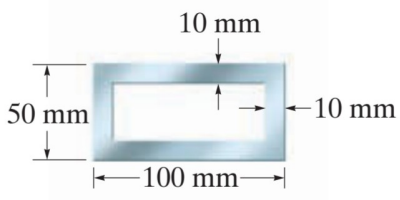
14. (a) Explain how normal and shear stress along a plain at a particular point is found using Mohr's circle. (7 marks)

(b) The grains of wood in the board make an angle of 20° with the horizontal as shown. Using Mohr's circle, determine the normal and shear stresses that act perpendicular and parallel to the grains if the board is subjected to an axial load of 250 N. (7 marks)



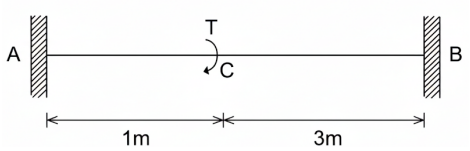
Module 3

15. An A-36 steel column has a length of 5 m and is fixed at both ends. If the cross-sectional area has the dimensions shown, determine the critical load. Take E = 200 GPa.



OR

16. A shaft of 4 cm in diameter and 4 m long is rigidly fixed at its ends. A torque of 1600 Nm is applied at a section 1 m from the left support. Calculate the fixing couples at the supports and the maximum torsional stress induced in the shaft. Also, calculate the angles of twist in degrees at the section where the torque is applied. Assume G = 84 GPa.



Module 4

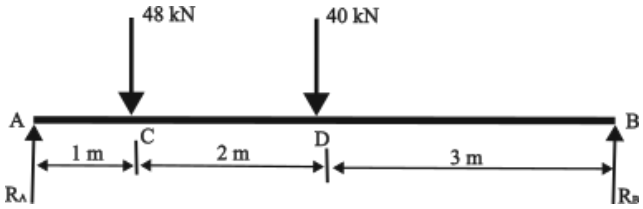
17. *A beam of length 6 m is simply supported at its ends and carries two-point loads of 48 kN and 40 kN at a distance of 1 m and 3 m from the left support. Find:*

1. Deflection under each load

2. Maximum deflection

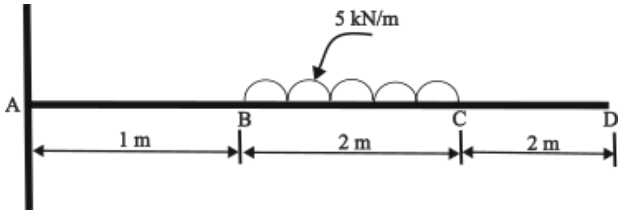
3. The point at which maximum deflection occurs

Take $E=2\times10^5$ N/mm² and $I= 85\times10^6$ mm⁴.



OR

18. *Draw SFD and BMD for a cantilever beam of span 5 m subjected to a UDL of 5 kN/m over a length of 2 m at a distance of 1 m from the fixed end. Find the maximum bending moment.*



Module 5

19. Derive the equation for the total strain energy in a three-dimensional and two-dimensional stress systems.

OR

20. In a steel member, at a point the major principal stress is 180 MN/m^2, and the minor principal stress is compressive. If the tensile yield point of the steel is 225 MN/m^2, find the value of the minor principal stress at which yielding will commence, according to each of the following criteria of failure: (i) Maximum shearing stress, (ii) Maximum total strain energy, and (iii) Maximum shear strain energy. Take Poisson's ratio = 0·26.

****