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**Indian Maritime University**  
**(A Central University, Govt of India)**

**Mar/Apr'26 SE**

**Programme Name: B Tech Marine Engineering**

**Semester: III**

**Subject Code: UG11T5302**  
**Subject Name: Solid Mechanics**

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Date: 20.03.2026  
Duration: 03 Hrs

Max Marks: 70  
Pass Marks: 35

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General Instructions

- (i) All Sections (A, B & C) are to be attempted.
- (ii) Options, if any, are specified in the respective section.

**Section A**

Ten MCQs/Fill in the Blanks of 01 Mark each – Choose the correct answer as applicable.

1. A propeller drive shaft has an outside diameter of 80 mm and an inside diameter of 60 mm. Its polar moment of inertia in  $\text{mm}^4$  will be

- a. 2567600
- b. 2748500
- c. 2747400
- d. 2747500

2. The proof resilience per unit volume of a material is known as

- a. modulus of resilience
- b. modulus of rigidity
- c. modulus of resistance
- d. Bulk Modulus

3. A steel bar of 40 mm x 40 mm square cross-section is subjected to an axial tensile load of 200 kN. If the length of the bar is 2m and  $E = 200 \text{ GPa}$ , the elongation of the bar will be

- a) 1.25 mm
- b) 2.50 mm
- c) 4.05 mm
- d) 5.5 mm

4. If a composite bar is cooled, then the nature of stress in the part with a high coefficient of thermal expansion will be

- a. Tensile
  - b. compressive
  - c. zero
  - d. none of the options
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5. When a solid shaft is subjected to torsion, the shear stress induced in the shaft at its centre is

- a. Zero
- b. minimum
- c. maximum
- d. average

6. A structure made of slender members where loads are applied at the joints only is called a:

- a. Truss
- b. Beam
- c. Pillar
- d. Support

7. Principal planes are those planes on which

- a. Normal stress is maximum
- b. Normal stress is minimum
- c. Normal stress is either maximum or minimum
- d. Shear stress is maximum

8. A shaft is said to be in pure torsion if

- a. Turning moment is applied at one end, and the other end is free
- b. Turning force is applied at one end, and the other end is constrained
- c. Two opposite turning moments are applied to the shaft
- d. A combination of torsional load and bending load is applied to the shaft

9. Two sample cylindrical bars, one made up of wood and the other of steel, are subjected to a compressive load of 10 kN. Each has an equal unit cross-sectional area, but the length of the steel bar is twice that of the wooden bar. Which of the following stress conditions is true?

- a. The steel bar will have more stress.
- b. The wooden bar will have more stress.
- c. Both will have the same stresses
- d. Stress will depend on the Young's modulus value of the material.

10. A solid steel shaft of 80 mm diameter is to be replaced by a hollow steel shaft of the same material with an external diameter of 100 mm. The internal diameter in mm will be

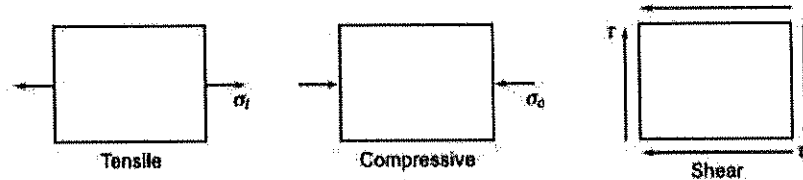
- a. 86.4
  - b. 83.6
  - c. 77.8
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d. 81.7

### Section B

#### Five Questions of 02 Marks each

11. For the following given simple stress conditions, draw the corresponding Mohr's circle for each case separately. What is the magnitude of the maximum principal stress in the pure shear case?



12. List any four assumptions in the theory of torsion.  
13. What are zero-force members in a Truss.  
14. Draw the stress-strain diagram for a mild steel specimen and show various salient points.  
15. Describe the relationship between all the moduli of elasticity, rigidity, and bulk modulus.

### Section C

Seven Questions of 10 Marks each, of which any 05 questions are to be answered.

16. A homogeneous bar of the cross-sectional area 500 sq.cm. is rigidly attached as shown in Figure 16.1. Determine the magnitude and nature of the stresses in each segment. Also, find the change in length of each segment. Take  $E = 200 \text{ GPa}$ .

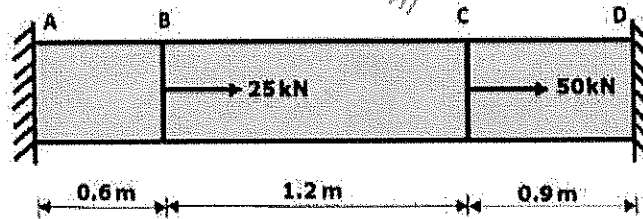


Figure 16.1.

17. A steel bar is placed between two copper bars, each having the same area and length as the steel bar, at an initial temperature of  $40^\circ \text{C}$ . Initially, all the bars are connected rigidly at both ends. When the temperature is raised to  $340^\circ \text{C}$ , the length of the bars increases by 2 mm. Calculate the final stresses and the original length in the bars.

Take  $E_s = 220 \text{ GN/m}^2$ ,  $E_c = 110 \text{ GN/m}^2$ ,  
 $\alpha_s = 0.000012 / ^\circ\text{C}$ ,  $\alpha_c = 0.0000175 / ^\circ\text{C}$

18. (a). Derive the equation of torsion, stating the necessary assumptions.  
 (b). A shell 3.25 m long and 1 m in diameter is subjected to an internal pressure of 1.2 N/mm<sup>2</sup>. The thickness of the shell is 10 mm. Compute the circumferential, longitudinal stresses and maximum shear stress and of the shell.  
 Take  $E = 200 \text{ kN/mm}^2$  and Poisson's ratio = 0.3.

19. The stresses acting at a point in a two-dimensional stress system are shown in Figure 19.1. Determine the principal planes, principal stresses, and the normal and tangential stresses acting on the plane AB. Also, draw a Mohr circle for the given stress system. Mark the salient points and stresses.

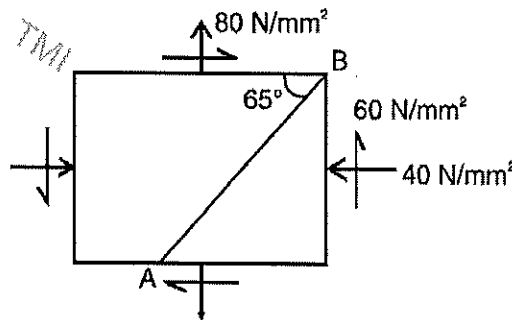


Figure 19.1

20. An inclined Truss is loaded as shown in the figure. Using the method of section, determine the magnitude and nature of the forces in the members BC, CK, and KJ of the Truss.

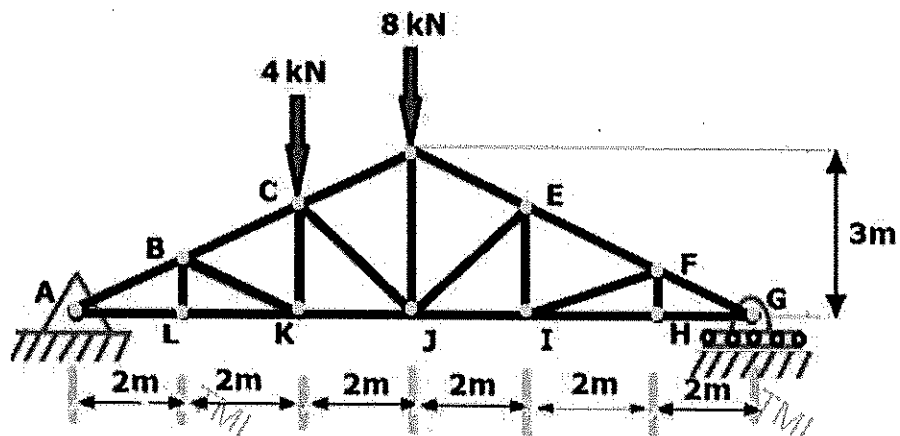


Figure 20.1

21. Figure 20.1 below shows a stepped steel shaft. It is subjected to a torque  $T$  at the free end and a torque  $2T$  in the opposite direction at the junction of the two sizes. Determine the total angle of twist if the maximum shear stress is limited to 70 MPa. Take modulus of rigidity  $G = 84$  GPa.

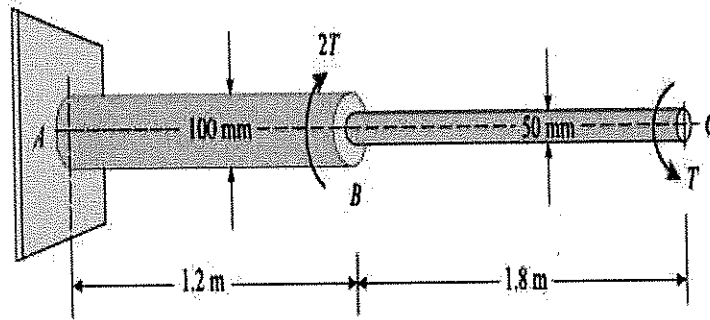


Figure 21.1

22. A rectangular bar 500 mm long and 100 mm x 50 mm in cross section is subjected to forces as shown in Figure 22.1. What is the change in the volume of the bar? Take modulus of elasticity for the bar material as 200 GPa and Poisson's ratio as 0.25.

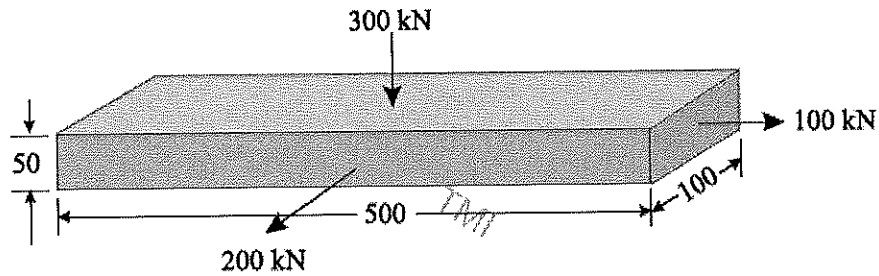


Figure 22.1

