Indian Maritime University

(A Central University, Govt of India)

End Semester Examinations – December 2025

Programme Name: B Tech (ME)

Semester: III

Subject Code: UG11T5302

Subject Name: SOLID MECHANICS

Date: 09.12.2025	Max Marks: 70
Duration: 03 Hrs	Pass Marks: 35

General Instructions

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

Section A

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

1. The ratio of lateral strain to the linear strain is called

(a) modulus of elasticity (b) modulus of rigidity
(c) bulk modulus (d) Poisson's ratio

2. If a piece of material neither expands nor contracts in volume when subjected to stresses, then the Poisson's ratio must be

(a) Zero (b) 0.25
(c) 0.33 (d) 0.5

3. Maximum strain energy stored in a body without permanent deformation is known as

(a) impact energy (b) proof resilience
(c) resilience (d) modulus of resilience

4. A truss is said to be a perfect truss if it satisfies:

(a) m=2j-R (b) m>2j-R
(c) m=2R-3 (d) 2j-R=2m

5. In a thin shell, the ratio of longitudinal stress to the circumferential stress is

(a) 1/4 (b) 3/4
(c) 1/2 (d) 2

6. Which of the following stresses can be determined using Mohr's circle method?

(a) Torsional stress (b) Principal stress
(c) Bending stress (d) All of the above

7. Strain energy due to torsion for solid circular shaft is

(a) $U = \frac{\tau^2}{4C} \times V$ (b) $U = \frac{\tau^3}{4C} \times V$
(c) $U = \frac{\sigma^2}{2E} \times V$ (d) $U = \frac{\tau^2}{4C}$

8. Thermal stress in a composite bar does not depend on which of the following factor?

(a) Area of cross-section (b) Coefficient of thermal expansion
(c) Temperature change (d) Modulus of elasticity

9. Oil tanks, steam boilers, gas pipes are examples of _____

(a) Thick shells (b) Thin cylinders
(c) Hoop cylinders (d) Longitudinal cylinders

10. The direction of resultant stresses on an oblique section is equal to

(a) $\frac{\sigma_n}{\tau}$ (b) $\sigma_n + \tau$
(c) $\frac{\tau}{\sigma_n}$ (d) $\sigma_n - \tau$

Section B

Five Questions of 02 Marks each

11. What is true stress and engineering stress?
12. Define Resilience and Modulus of Resilience.
13. A material has young's modulus 210 GN/m^2 & μ= 0.3. Calculate Bulk Modulus.
14. State the assumptions made in the analysis of pin jointed trusses.
15. Explain principal planes and principal stresses and discuss their uses.

Section C

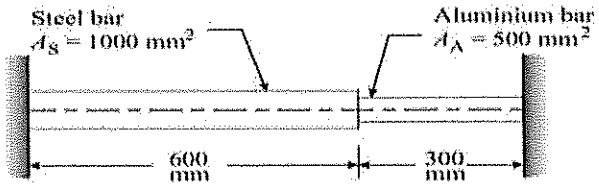
Seven Questions of 10 Marks each of which any 05 questions to be answered.

16. In an experiment, a bar of 30 mm diameter is subjected to a pull of 60 kN. The measured extension on gauge length of 200 mm is 0.09 mm and the change in diameter is 0.0039 mm. Calculate the Poisson's ratio, Bulk Modulus, Modulus of Rigidity and Young's Modulus.

(10 marks)

17. The bars are stress-free at a temperature of 38°C. What will be the stresses in the two bars, when the temperature is 21°C, if (a) the supports are unyielding, (b) the supports come nearer to each other by 0.1 mm? It can be assumed that the change of temperature is uniform all along the length of the bar.

Take E for steel as 200 GPa; E for aluminium as 75 GPa and coefficient of expansion for steel as 11.7 × 10^{-6} per °C and coefficient of expansion for aluminium as 23.4 × 10^{-6} per °C.



(10 marks)

18. A cylindrical shell of 1.3 m diameter is made up of 18 mm thick plates. Find the circumferential and longitudinal stress in the plates, if the boiler is subjected to an internal pressure of 2.4 MPa. Take efficiency of the joints as 70%.

(10 marks)

19. (a) An element in a stressed material has tensile stress of 500 MN/m^2 and a compressive stress of 350 MN/m^2 acting on two mutually perpendicular planes and equal shear stresses of 100 MN/m^2 on these planes. Determine the following:

i) Principal Stresses
ii) Position of principal planes
iii) Maximum shear stress

(b) Explain the procedure to draw Mohr's circle for Member subjected to Direct Stresses on two Mutually Perpendicular plane accompanied with Shear stress.

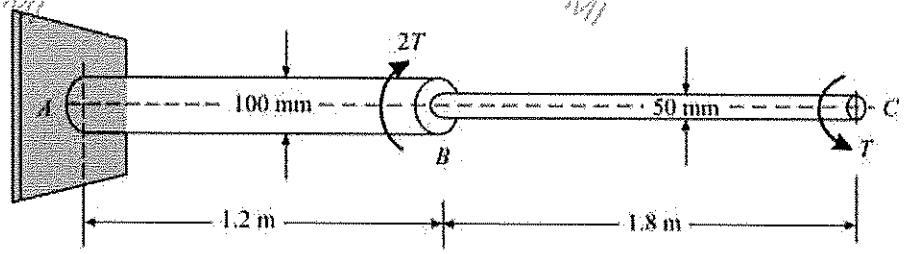
(7+3 Marks)

20. Write the assumption made in the theory of torsion. Derive the following relation for torsion.

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{L}$$

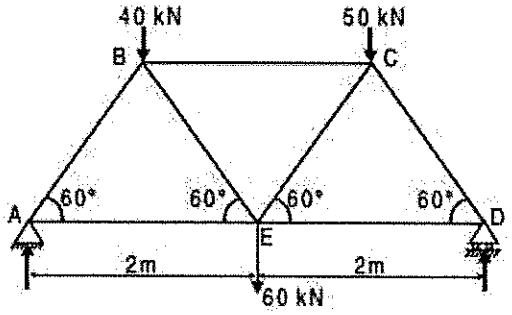
(10 marks)

21. The stepped steel shaft shown in Figure 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. What is the total angle of twist at the free end, if maximum shear stress in the shaft is limited to 70 MPa? Assume the modulus of rigidity to be 84 GPa.



(10 marks)

22. Determine the forces in all the members of the truss shown in Figure and indicate the magnitude and nature of forces on the diagram of the truss. All inclined members are at 60° to horizontal and length of each member is 2 m.



(10 marks)