

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

End Semester Examinations – December 2023
Programme Name: B. Tech (Marine Engineering)

Semester: III

Subject Code: UG11T4302

Subject Name: SOLID MECHANICS

Date: 06.12.2023 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. When mild steel is subjected to tensile loading, its fracture will conform to shape.
 - (a) granular
 - (b) star
 - (c) cup and cone
 - (d) none of these
2. The ratio of lateral strain to linear strain is known as
 - (a) modulus of elasticity
 - (b) modulus of rigidity
 - (c) Poisson's ratio
 - (d) elastic limit
3. The radius of Mohr's circle is equals to
 - (a) σ_x
 - (b) τ_{max}

- (c) σ_y
 - (d) $(\sigma_x + \sigma_y)/2$
4. Angle of twist of a circular shaft under the action of a torsional moment 'T' is given by
 - (a) GJ/TL
 - (b) TJ/TL
 - (c) TL/GJ
 - (d) TG/TL
 5. The ratio of the response amplitude of the system in steady-state forced vibration to the excitation amplitude is known as:
 - (a) Transmissibility
 - (b) Resonance
 - (c) Frequency
 - (d) none of these
 6. The rim of the flywheel is subjected to
 - (a) Torsional shear stress and bending stress
 - (b) Direct shear stress and bending stress
 - (c) Compressive stress and Bending stress
 - (d) Direct tensile stress and bending stress
 7. The materials which have the same elastic properties in all directions are called
 - (a) Isotropic
 - (b) Brittle
 - (c) Homogeneous
 - (d) Hard
 8. In thin cylindrical pressure vessel, hoop stress is _____ the longitudinal stress
 - (a) Twice
 - (b) Thrice
 - (c) One half

- (d) Equals to
9. When two dissimilar shafts are connected together, then the shaft is
- Integrated shafts
 - Composite shafts
 - Differential shafts
 - Combined shafts
10. The planes, which have are known as principal planes.
- equal shear and bending stresses
 - no bending stresses
 - high shear stresses
 - no shear stresses

Section B

Five Questions of 02 Marks each

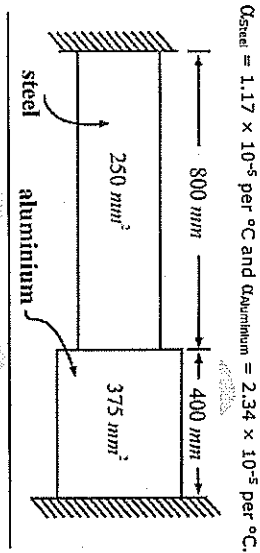
- Explain the term complex stress?
- Define proof resilience along with mathematical formula.
- Define the term resonance in vibration
- A 500 mm long copper rod is subjected to a torque so that the angle of twist between its ends is 2° . If the permissible shear strain is 0.0006, find the maximum permissible diameter of the rod.
- Explain the difference between Engineering Stress and True Stress?

Section C

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

16. (a) An object of 100 N weight falls by gravity a vertical distance of 5 m, when it is suddenly stop by a collar at the end of the vertical rod of length 10 m & diameter 20 mm. The top of the bar is rigidly fixed. Calculate the maximum stress & strain induced in the bar due to impact. Take $E = 200 \text{ GN/m}^2$ for the material of the rod.

- (b) The composite bar consisting of steel and aluminium components as shown in figure 2 is connected to two grips at the ends at a temperature of 60°C . Find the stresses in the two rods when the temperature falls to 20°C , if the ends do not yield. The areas of steel and aluminium bars are 250 mm^2 and 375 mm^2 respectively.



$\alpha_{\text{steel}} = 1.17 \times 10^{-5}$ per $^\circ\text{C}$ and $\alpha_{\text{aluminium}} = 2.34 \times 10^{-5}$ per $^\circ\text{C}$.

Take $E_{\text{steel}} = 2 \times 10^5 \text{ N/mm}^2$ and $E_{\text{aluminium}} = 0.7 \times 10^5 \text{ N/mm}^2$.

17. A particle, moving with simple harmonic motion, performs 10 complete oscillation per minute and its speed, is 60% of the maximum speed when it is at a distance of 8 cm from the centre of oscillation. Find amplitude, maximum acceleration of the particle. Also, find speed of the particle, when it is 6 cm far from the centre of oscillation. (05 marks)
18. (10 marks)
- Explain the longitudinal stress and circumferential stress in a thin cylindrical pressure vessel with the help of the diagram.
 - Derive a relation of change in dimension of a thin cylindrical shell due to an internal pressure.
19. (03+07 Marks)
- A helical coil spring is made of round steel wire 6 mm in diameter. The mean radius of helix is 30 mm, number of complete turns are 10; the spring is close-coiled. If $G = 84.36 \text{ GN/m}^2$, find
- pull required to extend the spring by 24 mm
 - stress in the wire

c) spring constant

(10 Marks)

20. At a point in a bracket the stresses on two mutually perpendicular planes are 500 MN/mm^2 tensile and 350 MN/mm^2 tensile. The shear stress across these planes is 250 MN/mm^2 . Determine:

- a) the magnitude and direction of principal stresses
- b) the maximum shear stress?

(7+3 marks)

21. Derive the Torsion equation for a shaft fixed at one end and torque being applied at the other end.

(10 marks)

22. A cylindrical vessel whose ends are closed by means of rigid flange plated, is made steel plate 3 mm thick. The length and the internal diameter of the vessel are 50 cm and 25 cm respectively. Determine the longitudinal and hoop stresses in the cylindrical vessel due to an internal fluid pressure of 3 MN/m^2 . Also calculate the increase in length, diameter and volume of the vessel. Take $E=200 \text{ GN/m}^2$ and $\mu=0.3$.

