Indian Maritime University

(A Central University, Govt of India)

End Semester Examinations – December 2024

Programme Name: B Tech (Marine Engineering)

Semester: III

Subject Code: UG11T4302

Subject Name: Solid Mechanics

Date: 09.12.2024	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 property of a material by virtue of which a body returns to its original shape after removal of the load is known as

A) ductility B) plasticity C) elasticity D) resilience

2. If the radius of a wire stretched by a load is doubled, then its Young's modulus will be.....

a) halved b) doubled c) become one-fourth d) remain unaffected

3. Temperature stress developed in a bar depends upon which of the following?

a) Coefficient of linear expansion b) Change of temperature
c) Young's modulus d) all of these

4. The shear stress at any point of a shaft, subjected to twisting moment, is The

a) proportional to its distance from the central axis of the shaft
b) inversely proportional to its distance from the central axis of the shaft
c) proportional to the square of its distance form the central axis of the shaft
d) none of the above

5. Hoop stress set up in a thin cylinder subjected to an internal fluid pressure is ..... the longitudinal stress.

a) twice b) thrice c) four times d) none of these

6. When a body is subjected to a direct tensile stress (σ) in one plane, then normal stress on an oblique section of body inclined at an angle Θ to the normal of the section is equals to.....

a) $\sigma \sin \Theta$ b) $\sigma \cos \Theta$ c) $\sigma \sin^2 \Theta$ d) $\sigma \cos^2 \Theta$

7. The angle made by resultant stress with normal stress is called an .....

a) angle of obliquity b) angle of repose

c) angle of friction d) none of these

8. When a helical compression spring is cut into two equal halves, the stiffness of each of the resulting spring will be

a) unaltered

b) double

c) one-half

d) one-fourth

9. A hollow shaft of same cross-sectional area as solid shaft transmits ..... torque

a) less b) same c) more d) unpredictable

10.) The maximum displacement of a body moving with simple harmonic motion from its mean position is called At resonance the amplitude of forced oscillations is.....

A) oscillation

B) amplitude

C) Beat

D) none of the above.

Section B

Five Questions of 02 Marks each

11. Draw a stress strain diagram for a ductile material and show the elastic limit, yield point and ultimate stress.

12. Define proof resilience and modulus of resilience.

13. Define compound stress.

14. Define the term torsion. List few examples of torsion application in engineering practice.

15. Define the term resonance in vibration.

Section C

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

16. A homogeneous bar of cross-sectional area 500 mm^2 is rigidly attached as shown in Figure 1. Determine the magnitude and nature of the stresses in each segment. Take E=200 GPa (10 marks)

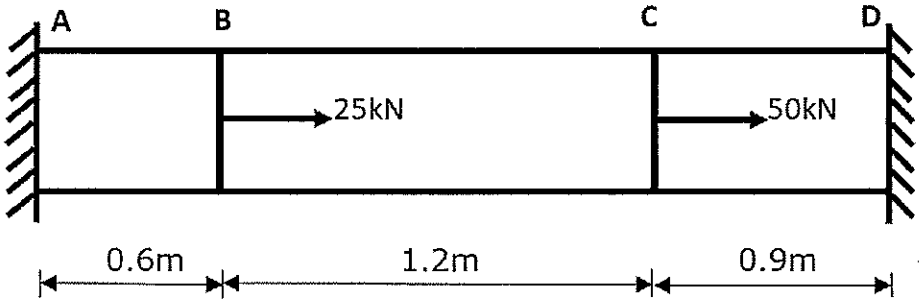
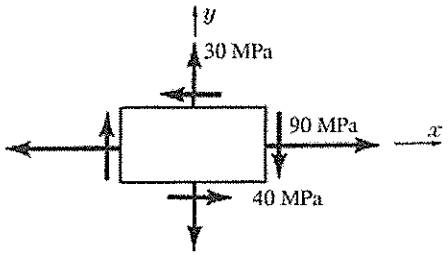


Figure-1

17. A plane element is subject to the stresses shown in Fig. 2. Determine



(a) the principal stresses and their directions. (6 Marks)

(b) the maximum shearing stresses and the directions of the planes on which they occur. Use the analytical approach. (4 Marks)

18. a) Derive the expression for circumferential stress in thin cylindrical shell (5 marks)

b) A cylindrical air drum is 2.25 m in diameter with plates 1.2 cm thick. The efficiencies of the longitudinal and circumferential joints are respectively 75

% and 40 %. If the tensile stress in the plating is to be limited to 120 MN/m^2. Find the maximum safe air pressure. (5 marks)

19. A point is subjected to a tensile stress of 250 MPa in the horizontal direction and another tensile stress of 100 MPa in the vertical direction. The point is also subjected to a simple shear stress of 25 MPa, such that when it is associated with the major tensile stress, it tends to rotate the element in the clockwise direction. What is the magnitude of the normal and shear stresses on a section inclined at an angle of 20 degree with the major tensile stress?

(10 marks)

20. Derive the maximum torque transmitted by a circular solid shaft. (10 marks)

21

a) For one propeller drive shaft, compute the torsional shear stress when it is transmitting a torque of 1.76 kN-m. The shaft is hollow tube having an outside diameter of 60 mm and an inside diameter of 40 mm. Find the stress at both the outer and inner surfaces. (5 marks)

b) A closed helical spring is made out of 10 mm diameter steel rod. The coil consists of 10 complete turns with a mean diameter of 120 mm. The spring carries an axial pull of 200 N. Find the maximum shear stress induced in the section of the rod. If G= 80 GN/m^2, find the deflection in the spring, stiffness and maximum shear stress. (5 marks)

22. The weight of an empty railway wagon is 240 kN. On loading it with goods weighing 320 kN, its spring gets compressed by 80 mm.

(a) Calculate its natural period of vibrations when the railway wagon is (i) empty and (ii) loaded as above. (5 Marks)

(b) It is set into natural vibrations with an amplitude of 100 mm when empty. Calculate the velocity of the railway wagon when its displacement is 40 mm from the statical equilibrium position (5 Marks)