Indian Maritime University

(A Central University, Govt of India)

End Semester Examinations – June 2023

Programme Name: B Tech (ME)

Semester: III

Subject Code: UG11T4302

Subject Name: Solid Mechanics

Date: 14.06.2023	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. Two sample cylindrical bar, one made up of wood and other steel, are subjected to compressive 10 kN load. Each has equal unit cross-sectional area but the length of steel bar is twice of wooden bar. Which following stress condition is true?
   a) Steel bar will have more stress.
   b) Wooden bar will have more stress.
   c) Both will have same stress.
   d) Stress will depend on Young's modulus value of material

2. The value of corresponding to force on whose removal deformation disappears is known as
   a. Proportional Limit
   b. Elastic Limit
   c. Yield Point
   d. Fracture

3. Which of the following options correctly define Proof Resilience?
   a. The maximum value of strain energy upto elastic limit
   b. The minimum value of strain energy beyond the elastic limit
   c. The maximum value of kinetic energy
   d. The Minimum value of strain energy

4. If a composite bar is cooled, then the nature of stress in the part with high coefficient of thermal expansion will be
   a) Tensile
   b) Compressive
   c) Zero
   d) None of the options

5. 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

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

a) Thick shells

b) Thin cylinders

c) Hoop cylinders

d) Longitudinal cylinders

7. When a body is subjected to the two mutually perpendicular stresses, σ_x and σ_y, then the centre of Mohr's circle from the origin is

a. $\frac{\sigma_x + \sigma_y}{2}$

b. $\frac{\sigma_x - \sigma_y}{2}$

c. $\frac{2\sigma_x + \sigma_y}{2}$

d. $\sigma_x + \sigma_y$

8. While calculating the stress induced in a closed coil helical spring, Wahl's correction factor must be considered to account for

   a) The curvature and stress concentration effect
   b) Shock loading
   c) Poor service conditions
   d) Fatigue loading

9. A shaft is said to be in pure torsion if
   a) Turning moment is applied at one end and other end is free
   b) Turning force is applied at one end and other end is free
   c) Two opposite turning moments are applied to the shaft
   d) Combination of torsional load and bending load is applied to the shaft

10. In vibration isolation, if ω/ω_n is less than $\sqrt{2}$; then for all values of the damping factor, the transmissibility will be

a) Equal to one

b)Zero
c)Less than one
d) Greater than one

Section B

Five Questions of 02 Marks each

11. Explain the difference between Engineering Stress and True Stress?

12. What is the difference between Proof Resilience and Modulus of Resilience?

13. 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.

14. Why hollow circular shafts are preferred when compared to solid circular shafts?

15. Explain deflection of helical spring? Write the mathematical express of the deflection of the spring.

Section C

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

16. A concentric cylinder of diameter 150 mm and length 300 mm when subjected to an axial compressive load of 200 kN resulted in an increase of diameter by 0.13 mm and decrease in length of 0.3 mm. Compute the value of Stress (σ), Poisson's Ratio (μ or 1/m) and Modulus of Elasticity (E)

(10 Marks)

17. i) A cylindrical cast-iron water tank is carrying a water at a pressure head of 120 m and is having an inside diameter of 0.9 m. If the tensile stress is to be limited to 20 MN/m^2 and weight of the water is 10 kN/m^3. Calculate the thickness of the metal required?

ii) Calculate the increase in volume of a spherical shell 1.5 m in diameter and 0.01 m thick, when it is subjected to an internal pressure of 2 MN/m^2.
Take Modulus of elasticity =200 GN/m^2, and Poisson's Ratio = 0.3

(5+5 Marks)

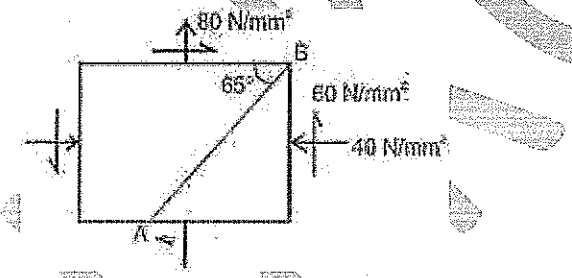
18. A steel bar is placed between two copper bars, each having the same area and length as steel bar at 40 ^{0}C. Initially, all the bars are connected rigidly at both the ends. When the temperature is raised to 340 ^{0}C, the length of the bars increases by 2 mm. Calculate the final stresses and the original length in the bars.

Take E_s = 220 GN/m^2, E_C = 110 GN/m^2, α_s = 0.000012 / ^{0}C, and α_c = 0.0000175 / ^{0}C

(10 marks)

19. A boiler is subjected to an internal steam pressure of 2 N/mm^2, the thickness of a boiler plate is 2cm and permissible tensile stress is 120 N/mm^2, find out the maximum diameter when efficiency of longitudinal joint is 90% and that of circumferential joint is 40%. (5+5) Marks

20. The stresses acting at a point in a two-dimensional stress system is shown in Figure. Determine the principal planes, principal stresses and the normal and tangential stresses acting on the plane AB. Also draw Mohr circle for given stress system. Mark the salient points and stresses. (10) Marks



21. A solid circular shaft is to be designed to transmit 22.5 kW power at 200 rpm. If the maximum shear stress is not to exceed 80 N/mm^2 and the angle of twist is not to exceed 1° per metre length, determine the diameter of the shaft. Take modulus of rigidity 80 kN/mm^2.

22. The end of one of the prongs of a tuning fork that executes simple harmonic motion of frequency 1000 Hz has an amplitude of 0.40 mm. Find
    (a) Maximum acceleration
    (b) Maximum speed of the end of the prong.
    (c) Acceleration
    (d) Speed of the end of the prong when the end has a displacement of 0.20 mm (2.5+2.5+2.5+2.5)Marks