

Indian Maritime University
(A Central University, Govt of India)
End Semester Examinations – December 2023
Programme Name: B.Tech (NAOE)
Semester: 3rd Sem.
Subject Code: UG12T2301
Subject Name: Strength of Materials

Date: 05.12.2023

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. If the principal stresses in a plane stress problem 100 MPa and 40 MPa, the magnitude of the maximum shear stress (in MPa) will be

- (a) 60
- (b) 50
- (c) 30
- (d) 20

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

- (a) $p \sin 2\theta$
- (b) $p \cos 2\theta$
- (c) $\frac{p}{2} \sin 2\theta$
- (d) $\frac{p}{2} \cos 2\theta$

3. The crippling load for a column by Euler's formula when both the ends are fixed.

- a) $(\pi^2 EI) / l^2$
- b) $(\pi^2 EI) / 4l^2$
- c) $4 (\pi^2 EI) / l^2$

d) $d \cdot 2(\pi^2 EI)/l^2$

4. The radial pressure P_x at any radius x in case of the thick cylinder is given by

(a) $P_x = b/x^2 - a$

(b) $P_x = b/x^2 + a$

(c) $P_x = x^2/b + a$

(d) $P_x = b/2x^2 - a$

5. Shear forces between any two vertical loads

(a) maximum

(b) minimum

(c) constant

(d) none

6. Section Modulus for rectangular section is _____

(a) $\frac{b^2 d}{12}$

(b) $\frac{bd^2}{6}$

(c) $\frac{b^2 d}{6}$

(d) $\frac{bd^2}{12}$

7. Two simply supported beams of the same span carry the same load. If the first beam carries the total load as a point load at its centre and the other uniformly distributed load over the whole span, then ratio of maximum slopes of first beam to the second will be

(a) 1:1

(b) 1:1.5

(c) 1.5:1

(d) 2:1

8. The maximum deflection that occurs for a simply supported beam with point load is

(a) $\frac{WL^3}{48EI}$

(b) $\frac{WL^3}{24EI}$

(c) $\frac{5WL^3}{384EI}$

(d) None of them

9. The slenderness ratio of a long column is

(a) 10-20

(b) 20-30

(c) 50-60

(d) above 80

10. The crippling load (P) for a column whose one end is fixed and other end is free is

- (a) $\frac{\pi^2 EI}{l^2}$
- (b) $\frac{4\pi^2 EI}{l^2}$
- (c) $\frac{\pi^2 EI}{4l^2}$
- (d) $\frac{2\pi^2 EI}{l^2}$

Section B

Five Questions of 02 Marks each

11. What is the volumetric strain of the cylindrical rod which is subjected to the axial tensile load?

12. Write short notes on a Mohr's circle of stresses.

13. Determine the Modulus of Rigidity, if the Poisson's ratio and Young's Modulus are 0.25 and 1.2×10^5 MPa respectively.

14. Write the formulae for slope and deflection for the simply supported beam of length span 'L' carrying a point load 'W'.

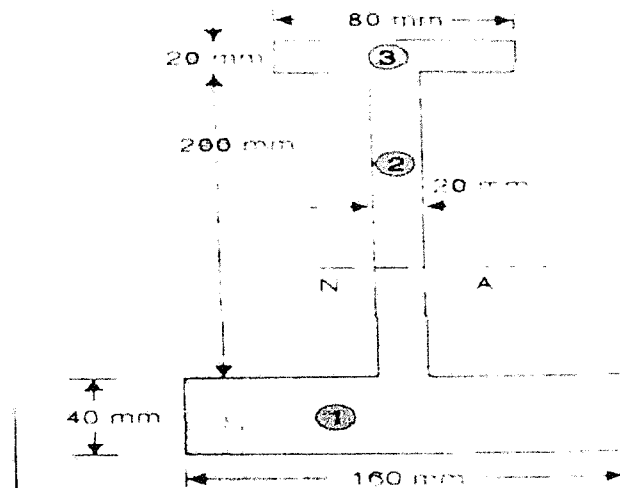
15. Write the formulae for circumferential stress and longitudinal stress of the thin cylinder whose internal diameter is 'd' and thickness of wall is 't' carrying internal pressure of 'p'.

Section C

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

16. A fixed beam of length 6m carries a point load of 160KN and 120KN at a distance of 2m and 4m from the left end A. Find the fixed end moments and the reactions at the supports. Draw bending moment shear force diagrams and find the maximum deflection.

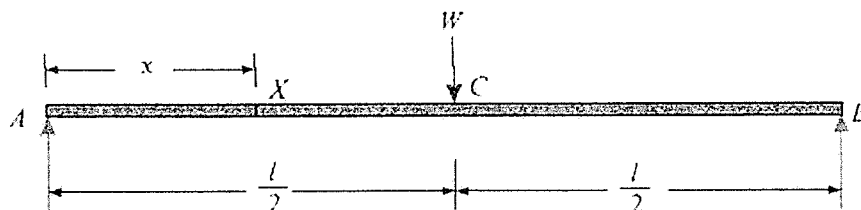
17. A cast iron beam is of I section as given in Figure. The beam is simply supported on a span of 5 meters. If the tensile stress is not exceeding 20 N/mm^2 , find the safe UDL which the beam can carry. Find also the maximum compressive stress.



18. (a) A cylindrical thin drum 800mm diameter and 4m long is made of 10mm thick plates. If the drum is subjected to an internal pressure of 2.5MPa, determine its changes in diameter and length. Take Young's modulus, $E = 200\text{GPa}$ and Poisson's ratio, $\nu = 0.25$. [4M]
- (b) A hollow alloy tube 4m long with external and internal diameters of 40mm and 25mm respectively was found to extend 4.8mm under a tensile load of 60kN. Find the Euler's buckling load for the tube with both ends pinned. [6M]

- 19 (a) Moment area method is to find deflection of beams and cantilevers which is based on Mohr's two theorems. Define Mohr's two theorems. [4M]
- (b) A fixed beam AB, 4m long, is carrying a central point load of 3 tonnes. Determine the fixing moments and deflection of the beam under the load. Take flexural rigidity of the beam as $5 \times 10^3 \text{ kN-m}^2$. [6M]

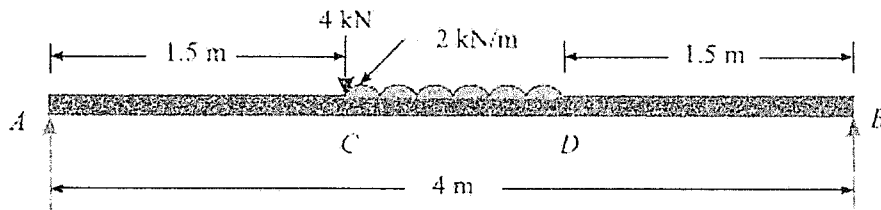
20. Find an expression for slope and deflection of a simply supported beam of span length 'l' with a central point load 'W' using Macaulay's method.



- 21 (a) A rod is 2m long at a temperature of 10°C . Find the expansion of the rod, when the temperature is raised to 80°C . If this expansion is prevented, find the stress induced in the material of the rod. Take $E = 1 \times 10^5 \text{ MPa}$ and $\alpha = 0.000012 / ^\circ\text{C}$. [5M]
- (b) In Mohr's circle method, 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 clockwise direction. What is the magnitude of normal and shear stresses inclined on a section at an angle of 20° with the major tensile stress? [5M]

22 (a) A simply supported beam of 4m span is carrying loads as shown in below figure. Draw Shear force and Bending Moment diagrams along with their magnitude at each point. [7M]



(b) A copper wire of 2mm diameter is required to be wound around a drum. Find the minimum radius of the drum, if the stress in the wire is not to exceed 80MPa. Take $E_{\text{Copper}} = 100\text{GPa}$. [3M]