



**K. K. Wagh Institute of Engineering Education & Research, Nashik**  
(An Autonomous Institute From A.Y. 2022-23)

WINTER-2024	
Exam Seat No.:	
Academic Year:2024-2025	Semester:I
Class:PG-I	Program:M.Tech
Branch Code:CIV	Pattern:2024
Name of Course:Advanced Solid Mechanics	Course Code:2404503
Max. Marks:60	Duration:2.30 Hrs.

**Instructions:** Candidates should read carefully the instructions printed on the Question Paper and on the cover page of the Answer Book, which is provided for their use.

1. This question paper contains 02 pages.
2. Answer to each new question is to be started on a new page.
3. Assume suitable data wherever required, but justify it.
4. Draw the neat labelled diagrams, wherever necessary.
5. The last columns indicates the Course Outcome and level of Blooms Taxonomy of the Question/sub-question.

**Marks CO**

**Question No. 1**

- 1a) Describe the concept of stress at a point and its significance in mechanics. Derive the expression for the stress tensor in Cartesian coordinates. (6) CO1, CO3, CO5

**Question No. 2**

- 2a) Define and explain the generalized Hooke's law. Illustrate the stress-strain relationship for plane strain conditions. (6) CO1, CO3, CO5

**Question No. 3**

- 3a) Derive the equilibrium equations and strain-displacement relations for axisymmetric systems. (8) CO1, CO2, CO3, CO4, CO5

**OR**

- 3b) Derive the torsion equation for a prismatic bar with an elliptical cross-section using St. Venant's theory. (8) CO1, CO2, CO3, CO4, CO5
- 3c) A cylindrical pressure vessel has an inner radius of 300 mm and an outer radius of 400 mm. It is subjected to an internal pressure of 10 MPa and an external pressure of 3 MPa. Calculate the radial and hoop stresses at the inner and outer surfaces. (8) CO1, CO2, CO3, CO4, CO5

**OR**

- 3d) A thick cylinder with an internal radius of 120 mm and an external radius of 250 mm is subjected to an internal pressure of 6 MPa. Assuming plane strain conditions, calculate: (8) CO1, CO2, CO3,

(i) Radial stress and hoop stress at a radius of 180 mm.

CO4,  
CO5

(ii) Maximum shear stress within the cylinder.

**Question No. 4**

4a) Elaborate on the different yield criteria: Tresca, Von Mises, and Mohr's theory of yielding.

(8) CO3,  
CO4,  
CO5

**OR**

4b) Describe the stress-strain curve for a material exhibiting perfectly plastic behavior.

(8) CO3,  
CO4,  
CO5

4c) A cylindrical bar of diameter 60 mm is subjected to uniaxial tension. The yield stress of the material is 300 MPa. Using Tresca's criterion, determine the maximum shear stress at the point of yielding.

(8) CO3,  
CO4,  
CO5

**OR**

4d) A cylindrical bar of diameter 50 mm is subjected to uniaxial tension. The yield stress of the material is 250 MPa. using Von Mises' criterion to calculate the equivalent stress at yielding.

(8) CO3,  
CO4,  
CO5

**Question No. 5**

5a) Describe the stress-strain curve for a material exhibiting perfectly plastic behavior.

(8) CO3,  
CO4,  
CO5

**OR**

5b) Discuss the problem of plastic torsion and derive general relations governing plastic torsion.

(8) CO3,  
CO4,  
CO5

5c) A thick-walled cylinder with an inner radius of  $r_i = 120\text{mm}$  and an outer radius of  $r_o = 250\text{mm}$  is subjected to an internal pressure of 150 MPa. The yield stress of the material is 300 MPa, and the cylinder obeys Tresca's yield criterion.

(8) CO3,  
CO4,  
CO5

Determine:

1. The elastic limit pressure.
2. The pressure at which the cylinder becomes fully plastic.

**OR**

5d) A solid circular shaft with a radius of  $r = 60\text{mm}$  is subjected to a torsional moment  $T$ . The material has a yield stress of 300 MPa and follows the plasticity theory of torsion. Assume the stress distribution is linear in the elastic region and constant in the plastic region.

(8) CO3,  
CO4,  
CO5

Determine:

1. The torque at the elastic limit.
2. The fully plastic torque.

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