P.E.S. COLLEGE OF ENGINEERING

(AN AUTONOMOUS INSTITUTE)

CHH. SAMBHAJINAGAR-431002

Regular Winter Examination – 2025

Course: F.Y.M.Tech. Branch : Structural Engineering Semester : I
Subject Code & Name: MTPESSE101T– Theory of Elasticity and Plasticity

Max Marks: 60 Date: Duration: 3 Hr.

Instructions to the Students:

1. *All the questions are compulsory.*
2. *The level of question/expected answer as per OBE or the Course Outcome (CO) on which the question is based is mentioned in ( ) in front of the question.*
3. *Use of non-programmable scientific calculators is allowed.*
4. *Assume suitable data wherever necessary and mention it clearly.*

		(Level/CO)	Marks
Q. 1	**Solve Any one of the following.**		
A)	Derive the stress equilibrium equations in the Cartesian coordinate system, considering no body forces.	**K2/CO1**	**12**

Solution:- Marking Scheme

Content	**Marks Distribution**
Assumptions & element	**1**
Stress components	**1**
X-direction equilibrium	**3**
Y-direction equilibrium	**3**
Z-direction equilibrium	**3**
Significance	**1**

		(Level/CO)	Marks
B)	The state of stress at a particular point relative to the xyz coordinate system is given by the stress matrix.	**K4/CO1**	**12**

$$\begin{bmatrix} 15 & 10 & -10 \\ 10 & 10 & 0 \\ -10 & 0 & 40 \end{bmatrix} \text{MPa}$$

Determine the normal stress and the magnitude and direction cosines of the shear stress on a surface intersecting the point and parallel to the plane by the equation. $2x - y + 3z = 9$.

Solution:- Marking Scheme

Content	**Marks Distribution**
Calculation of Normal Stress	**3**
Calculation of Shear Stress	**3**
Resultant Stress	**3**
Direction cosines of the shear stress	**3**

		(Level/CO)	Marks
Q.2	**Solve Any one of the following.**		
A)	Derive the relationships among Young's modulus (E), shear modulus (G), bulk modulus (K), and Poisson's ratio (ν) for isotropic materials. Explain the physical significance of each constant.	**K2/CO2**	**12**

Solution:- Marking Scheme

Content	**Marks Distribution**

Definitions of E, G, K, ν	**3**
Mathematical derivation	**5**
Final relations	**2**
Physical significance	**2**

B) Explain asymmetrical bending of beams with a neat sketch.
Derive the expression for bending stress in beams subjected to bending about both principal axes.

K2/CO2 **12**

Solution:- Marking Scheme

Content	**Marks Distribution**
Definition & explanation	**2**
Neat sketch	**2**
Stress derivation	**5**
Final expressions	**3**

Q. 3 **Solve Any one of the following.**

A) An infinite plate with a circular hole of radius a = 50 mm is subjected to a uniform tensile stress of 100 MPa at infinity.
Determine:
(a) Circumferential stress at the edge of the hole
(b) Maximum stress and stress concentration factor

K4/CO3 **12**

Solution:- Marking Scheme

Content	**Marks Distribution**
Given data & assumptions	**2**
Formula application	**4**
Calculation of stresses	**4**
Final answer & SCF	**2**

B) Explain Michell's problem of a concentrated load acting at the vertex of a wedge. Derive the expressions for stress components and discuss stress singularity at the vertex.

K2/CO3 **12**

Solution:- Marking Scheme

Content	**Marks Distribution**
Problem description	**3**
Governing equations	**3**
Stress derivation	**4**
Stress singularity discussion	**2**

Q.4 **Solve Any one of the following.**

A) Explain St. Venant's theory of torsion.State its assumptions and limitations, and discuss its applicability to non-circular sections.

K2/CO4 **12**

Solution:- Marking Scheme

Content	**Marks Distribution**
Theory explanation	**4**
Assumptions	**3**
Limitations	**3**
Applications	**2**

B) Define warping in torsion.Explain the warping behavior of rectangular and thin-walled open sections with neat sketches.

K2/CO4 **12**

Solution:- Marking Scheme

Content	**Marks Distribution**
Definition of warping	**3**
Rectangular section explanation	**4**
Thin-walled open section	**3**
Sketch AND presentation	**2**

<table>
<tr><td>Q. 5</td><td>Solve Any one of the following.</td><td></td><td></td></tr>
<tr><td>A)</td><td>Explain the flow theory of plasticity.
Derive the plastic strain increment relations using an associated flow rule.

Solution:- Marking Scheme
<table><tr><td>Content</td><td>Marks Distribution</td></tr><tr><td>Concept of flow theory</td><td>4</td></tr><tr><td>Flow rule derivation</td><td>4</td></tr><tr><td>Stress–strain relations</td><td>2</td></tr><tr><td>Applications</td><td>2</td></tr></table></td><td>K2/CO5</td><td>12</td></tr>
<tr><td>B)</td><td>Explain the deformation theory of plasticity.
Compare it with the flow theory and discuss their applications and limitations.

Solution:- Marking Scheme
<table><tr><td>Content</td><td>Marks Distribution</td></tr><tr><td>Theory explanation</td><td>4</td></tr><tr><td>Governing relations</td><td>3</td></tr><tr><td>Comparison with flow theory</td><td>3</td></tr><tr><td>Applications & limitations</td><td>2</td></tr></table></td><td>K2/CO5</td><td>12</td></tr>
<tr><td></td><td colspan="2">*** End ***</td><td></td></tr>
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