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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

First Semester, M.Tech. - Mechanical Engineering (MMDN)

Semester End Examination; April / May -2021

Theory of Elasticity

Time: 3 hrs *Max. Marks: 100*

Course Outcomes

The Students will be able to:

CO1: Describe the state of stress and solve principal stresses at a point in a continuous body.

CO2: Describe state of a strain at a point and solve principal strains in a continuous body.

CO3: Develop stress and strain relations for isotropic and composite materials.

CO4: Analyze the elasticity problems based on concept of energy.

CO5: Analyze bending and shear stresses and deflections induced in beams and torsional stresses in different members. Solve stresses in composite cylinders and stress concentration in a plate with hole.

Note: I) *Answer any* ***FIVE*** *full questions, selecting* ***ONE*** *full question from each unit.*

II) *Any* ***THREE*** *units will have internal choice and remaining* ***TWO*** *unit questions are compulsory.*

III) *Each unit carries 20 marks.* ***IV)*** *Missing data, if any, may suitably be assumed.*

Q. No.		UNIT - I	Marks	BLs	COs
1	a.	Define octahedral stress. Derive expression for octahedral normal and shear stresses in terms of stress invariants.	10	L2	CO1
	b.	For the following of stress, find the state of stress with respect to an axis, obtained by rotating the Z-axis, through 30° counter clockwise. $[\sigma_{ij}] = \begin{matrix} 100 & 80 & 0 \\ 80 & -60 & 0 \\ 0 & 0 & 40 \end{matrix}$ Kpa	10	L3	CO1
		OR			
1	d.	Derive Cauchy's stress relation for the resultant normal and shear stresses on an arbitrary plane.	10	L2	CO1
	e.	A rectangular component at a point are given as follows: $[\sigma_{ij}] = \begin{bmatrix} 10 & 4 & 6 \\ 4 & 2 & 8 \\ 6 & 8 & 6 \end{bmatrix}$ MPa i) Resolve the given state into hydrostatic and pure shear state ii) Find the stresses on octahedral plane.	10	L3	CO1
		UNIT - II			
2	a.	Derive compatibility equations in terms of strains and state their physical significance.	10	L2	CO2
	b.	The strain components at a point are given by, $\varepsilon_x = 0.01,\ \varepsilon_y = -0.02,\ \varepsilon_z = 0.03,\ \gamma_{xy} = 0.015,\ \gamma_{yz} = 0.02,\ \gamma_{zx} = -0.01$ Determine the normal and shearing strains on the octahedral plane.	10	L3	CO2

Contd… 2

OR

2 d.	The displacement field for a body is given by, $U = [(X^2 + Y^2 + 2)i + (3X + Y^2)j + (2X^3 + YZ)]$ What are the strain components at (1, 2, 3) and express it in a matrix form?	10	L3	CO2
e.	If a strain at a point is given follows: $\varepsilon_x = 4\times10^{-3},\ \varepsilon_y = 3\times10^{-3},\ \varepsilon_z = 2\times10^{-3}, \gamma_{xy} = 2\times10^{-3}, \gamma_{yz} = 1\times10^{-3}$ $\gamma_{zx} = -3\times10^{-3}$ Determine principle strain.	10	L3	CO2

UNIT - III

3 a.	Write a short notes on, i) Principle of Superposition ii) Saint-Venant's principle iii) Uniqueness theorem iv) Reciprocal theorem	20	L2	CO3

OR

3 d.	State the generalized Hooke's law and show that it can be expressed in terms of elastic constants.	10	L2	CO3
e.	Explain the following: i) Inverse and Semi-inverse methods in solving elastic problems ii) Membrane analogy	10	L2	CO3

UNIT - IV

4 a.	Derive an expression for strain energy due to, i) Axial force ii) Shear force iii) Bending moment iv) Torque	16	L2	CO4
b.	Explain Kirchhoff's theorem.	4	L2	CO5

UNIT - V

5 a.	Derive an expression for the tangential and radial stress equation for a thick cylinder, subjected to internal and external pressure, using the stress function.	10	L2	CO5
b.	A shaft consisting of a prismatic bar having an elliptical cross-section with a major axis of '2h' and minor axis of ' 2b' is subjected to a twisting moment *T*. Find the shearing stresses in the shaft in the fibers at the ends of major and minor axes of cross-section in terms of applied torque.	10	L2	CO5

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