U.S.N | | | | | | | | | | |

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

(An Autonomous Institution affiliated to VTU, Belagavi)

First Semester, M.Tech. - Civil Engineering (MCAD)

Semester End Examination; April / July - 2021

Continuum Mechanics - Classical and FE Approach

Time: 3 hrs *Max. Marks: 100*

Course Outcomes

The Students will be able to:

CO1: Understand the concept of stresses and analyze the various mathematical operations involved I analyzing stresses in 2D and 3D problems in Cartesian and polar coordinates.

CO2: Apply the concept of stain at a point and to get acquaint with the various mathematical operations involved in analysis strains in 2D and 3D problems in Cartesian and polar coordinates .

CO3: Develop general stress strain relations and understand its application in various cases.

CO4: Apply the basic principles of theory of plasticity to understanding the plastic behaviour of materials and theories of failure.

***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	CO	PO
1a.	Derive equation of equilibrium for three dimensional problems in Cartesian coordinates.	12	L3	CO1	PO2
b.	The ratio of normal stresses at a point in three dimensional state of stress is 1:–2:4. Find the ratio of linear strains in these directions.	8	L3	CO1	PO2
	OR				
1d.	A rectangular bar of cross section 40×30 mm is subjected to an axial tensile force of 180 kN. Calculate the normal, shear and resultant stresses on a plane whose normal has the following direction of cosine $l = m = \frac{1}{\sqrt{2}}$ and $n = 0$.	8	L3	CO1	PO2
e.	Derive the equilibrium equation in polar coordinate system.	12	L3	CO1	PO2
	UNIT - II				
2 a.	The strain components at a point are given by, $\varepsilon_x = 0.01,\ \varepsilon_y = -0.02, \varepsilon_z = 0.03, \gamma_{xy} = 0.015, \gamma_{yz} = 0.02, \gamma_{xz} = -0.01$ Determine the normal and shear strains on the octahedral plane.	8	L3	CO2	PO2
b.	Derive the compatibility equation for plane strain problem.	12	L3	CO2	PO2
	OR				
2 d.	Under what conditions are the following expressions for the components of strain at a point compatible? $\varepsilon_x = 2axy^2 + by^2 + 2cxy, \varepsilon_y = ax^2 + bx, \gamma_{xy} = \alpha x^2 y + \beta xy + ax^2 + \eta y$	8	L3	CO2	PO2

		Marks	BL	CO	PO
e.	Obtain strain displacement relation for two dimensional problems in polar coordinate system.	12	L3	CO2	PO2

UNIT - III

3 a.	Given the following stress function: $\varphi = \frac{P}{\pi} r^4 \theta^3 \sin\theta$. Determine the stress component σ_r, σ_θ *and* $z_{r\theta}$	10	L3	CO3	PO2
b.	The strain at a point is given by, $\varepsilon_x = 0.002,\ \varepsilon_y = -0.004, \varepsilon_z = 0, \gamma_{xy} = 0, \gamma_{yz} = -0.005, \gamma_{xz} = 0.02$ E = 210 GPa, μ = 0.3. Determine the stress tensor at this point also calculate Lame's constant.	10	L3	CO3	PO2

UNIT - IV

4 a.	Derive expression for radial and hoop stresses in a thick cylinder subjected to internal and external pressure. Hence, obtain the expression for radial and hoop stresses when the cylinder subjected to only internal pressure.	20	L3	CO3	PO3

OR

4 d.	A compound cylinder is formed by shrink fitting one cylinder over the other, the internal radius is 150 mm, external radius is 240 mm and the radius of the interface between the two cylinders is 210 mm. If the shrink fit induces a radial stress of 10 MPa between the two cylinders at the interface. Determine what is the shrink fit allowance between the outer radius of the inner cylinder and inner radius of the outer cylinder? Take $E = 2 \times 10^5$ N/mm^2.	20	L4	CO3	PO3

UNIT - V

5 a.	Evaluate the Jacobian matrix and strain displacement matrix for 4 noded rectangular element with vertices 1(0, 0), 2(40, 0), 3(40, 30) and 4(0, 30) mm. Take $\varepsilon = \eta = \frac{1}{\sqrt{3}}$, Thickness t = 20 mm.	14	L3	CO4	PO3
b.	Develop the Jacobian matrix for the triangular element.	6	L3	CO4	PO1

* * *