Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME SEMESTER – I (OLD) EXAMINATION – SUMMER 2017

Subject Code:710901N **Date:08/05/2017**

Subject Name: Theory of Elasticity

Time:02:30 P.M. to 05:00 P.M. **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** For the displacement field $u = [y^2i + 3yzj + (4+6x^2)k]10^{-2}$; determine the rectangular strain components at point P(1, 0, 2). **07**

(b) Derive the Cauchy stress formula. **07**

Q.2 **(a)** Derive the equation for cubic dilatation in three dimensional Cartesian coordinate system. **07**

(b) For the given state of stress, determine the principal stresses and their directions. **07**

$$[\tau_{ij}] = \begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix}$$

OR

(b) For the given state of strain, determine the principal strains and the direction of maximum and minimum principal strains. **07**

$$[\varepsilon_{ij}] = \begin{bmatrix} 0.02 & -0.04 & 0 \\ -0.04 & 0.06 & -0.02 \\ 0 & -0.02 & 0 \end{bmatrix}$$

Q.3 **(a)** For the plane state of stress derive; **07**

$$\sigma_1, \sigma_2 = \frac{\sigma_x + \sigma_y}{2} \pm \left[\left(\frac{\sigma_x - \sigma_y}{2} \right)^2 + \tau_{xy}^{\ 2} \right]^{1/2}$$

$$\tau_{max} = \left[\left(\frac{\sigma_x - \sigma_y}{2} \right)^2 + \tau_{xy}^{\ 2} \right]^{1/2}$$

(b) At a point in a body σ_x = 10000 Mpa, σ_y = -5000 Mpa, σ_z = -5000 Mpa, $\tau_{xy} = \tau_{yx} = \tau_{zx}$ = 10000 Mpa. Determine the normal and shearing stresses on a plane that is equally inclined to all the three axes. **07**

OR

Q.3 **(a)** Explain plane state of strain with its mathematical expressions **07**

(b) Derive equation for octahedral normal stress and octahedral shear stress. **07**

Q.4 **(a)** Explain Menabrea's theorem. **07**

(b) (i) Define axisymmetric problems giving suitable example. **02**

(ii) Define circumferential strain, radial strain and axial strain with the help of necessary sketch and expressions. **05**

OR

Q.4	**(a)**	Write a Hooke's law and extend this concept to derive generalized Hooke's law for relating six strain components with stress components assuming linear variation of stress with strain for homogeneous material. Using this law derive a stress strain relationship for linear, elastic, homogeneous and isotropic material.	**07**
	(b)	Explain Kirchhoff's theorem.	**07**
Q.5	**(a)**	Define bulk Modulus K and express it in terms of the Lame's coefficient λ and μ. For steel having $E = 207 \times 10^6$ kPa and $\nu = 0.3$ calculate λ, μ and K.	**07**
	(b)	Draw and comment on the nature of the Mohr's circle diagram for the following cases where in the three principal stresses σ_1, σ_2 and σ_3 are given as: (i) unequal (ii) equal (iii) any two of them are equal.	**07**
		OR	
Q.5	**(a)**	Explain Maxwell-Betti-Rayleigh reciprocal theorem.	**07**
	(b)	Determine the stresses induced in the rotating disc of uniform thickness.	**07**

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