Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER-1 (OLD) EXAMINATION – WINTER 2016

Subject Code: 711503N **Date:19/11/2016**

Subject Name: Advanced Solid Mechanics

Time:10:30 Am to 1:00 Pm **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)**	Explain the generalized Hooke's law. Derive the stress-strain relationship for Isotropic materials and the relationship between the elastic constants.	**07**
	(b)	Explain soap film bubble analogy and establish the equation with usual notations: $\nabla 2\ (\varphi/2G\theta) = \nabla 2\ (sz/p) = -1$.	**07**
Q.2	**(a)**	Find the principal stresses using Cardan's method and the direction cosines of principal stresses. Normal stresses: σ_{xx} = 600 MPa, σ_{yy} = – 140 MPa, σ_{zz} = –100 MPa, and Shear stresses: τ_{xy} = 20 MPa, τ_{yz} = 45 MPa, τ_{zx} = – 30 MPa,	**07**
	(b)	Draw the neat sketch for the displacement of an element. Also, derive the equation for various strains in Polar Coordinate System.	**07**
		OR	
	(b)	Derive the expression for radial and tangential stress for a solid circular plate of small uniform thickness, material density ρ, rotating about the center with angular velocity ω.	**07**
Q.3	**(a)**	Derive the equation of curved beams subjected to bending moment. State the various boundary conditions for the same.	**07**
	(b)	A solid circular shaft up of cast iron is 2.4 m long & fixed at one end is subjected to a torque T = 500 N-m at the free end. Determine the smallest radius so that it does not fail according to the maximum normal stress theory. The ultimate tensile stress of cast iron is 120 MPa.	**07**
		OR	
Q.3	**(a)**	Explain the concept of stability of structures. State the basis of stability of analysis for a slender straight column as well as column initially bent.	**07**
	(b)	Determine the principal stresses and direction cosines of any one principal stress for the following state of stresses. $\begin{bmatrix} 9 & 6 & 3 \\ 6 & 5 & 2 \\ 3 & 2 & 4 \end{bmatrix}$ MPa	**07**
Q.4	**(a)**	Discuss effect of transverse shear on buckling of the beam & derive equation of critical load for the same.	**07**
	(b)	At a point in a strained ductile material, the biaxial state of stresses are acting as σ_x = -100 MPa (C), σ_y = 0 & τ_{xy} = 100 MPa. If yield strength of the material is 250 MPa, check whether the material is safe using maximum shear stress theory and/or maximum distortion energy theory.	**07**
		OR	
Q.4	**(a)**	State the characteristics of Airy's stress function. Is $\Phi = A\ (y^4 - 3x^2y^2)$ representing Airy's stress function? Here, A is a constant.	**07**
	(b)	Derive equation of buckling load & deformation for the column with one	**07**

end free & other fixed which produces structural instability.

Q.5 **(a)** Establish the following equation with usual notations: **07**

$\varepsilon\theta = ½ (\varepsilon x + \varepsilon y) + ½ (\varepsilon x - \varepsilon y) \text{ Cos } 2\theta + \varepsilon xy \text{ Sin } 2\theta$

(b) Explain "Octahedral Planes" and derive the expressions for normal stresses and shear stresses for such planes. **07**

OR

Q.5 **(a)** Given the following stress field in MPa : **07**

$\sigma_x = 1.31x^3 + 0.0512y$, $\sigma_y = 1.1\ x^2 + 13.2$ & $\tau_{xy} = 2.7z + 2.2y^2$. Calculate strain at a point (3, 5, 2). Assume E= 210 GPa & Poisson's ratio $\nu = 0.17$.

(b) Draw the neat sketch for an element subjected to body forces, radial stresses, transverse stresses and shear stresses. **07**

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