Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME SEMESTER – I (OLD) EXAMINATION – SUMMER 2017

Subject Code: 711503N **Date:10/05/2017**

Subject Name: Advanced Solid Mechanics

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)**	Draw a neat sketch for an element subjected to body forces, radial stresses, transverse stresses and shear stresses.	**07**
	(b)	Write on "Octahedral Planes" and derive the expressions for normal stresses and shear stresses for such planes.	**07**
Q.2	**(a)**	Explain the effect of transverse shear on buckling of the beam & establish the equation of critical load.	**07**
	(b)	Check whether the material is safe using maximum shear stress theory and/or maximum distortion energy theory for a point in a strained ductile material, the biaxial state of stresses are acting as σ_x = -210 MPa (C), σ_y = 0 & τ_{xy} = 175 MPa. If yield strength of the material is 250 MPa.	**07**
		OR	
	(b)	Explain soap film bubble analogy and derive the equation with usual notations: $\nabla 2\ (\varphi/2G\theta) = \nabla 2\ (sz/p) = -1$.	**07**
Q.3	**(a)**	Determine the principal stresses using Cardan's method and the direction cosines of principal stresses. Normal stresses: σ_{xx} = 300 MPa, σ_{yy} = – 100 MPa, σ_{zz} = –120 MPa, and Shear stresses: τ_{xy} = 10 MPa, τ_{yz} = 40 MPa, τ_{zx} = – 25 MPa,	**07**
	(b)	Establish 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**
		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)	Establish the equation of curved beams subjected to bending moment. State the various boundary conditions for the same.	**07**
Q.4	**(a)**	A solid circular shaft up of cast iron is 2.0 m long & fixed at both ends is subjected to a torque T = 300 N-m at one 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 130 MPa.	**07**
	(b)	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**
		OR	
Q.4	**(a)**	Calculate strain at a point (3, 5, 2) for the following stress field. $\sigma_x = 1.31x^3 + 0.0512y$, $\sigma_y = 1.1\ x^2 + 13.2$ & $\tau_{xy} = 2.7z + 2.2y^2$.Assume E= 210 GPa & Poisson's ratio ν = 0.17.	**07**
	(b)	Derive the following equation with usual notations: $\varepsilon\theta = ½\ (\varepsilon x + \varepsilon y) + ½\ (\varepsilon x - \varepsilon y) \text{ Cos } 2\theta + \varepsilon xy \text{ Sin } 2\theta$	**07**

Q.5	**(a)**	Derive the stress-strain relationship for Isotropic materials and the relationship between the elastic constants.	**07**
	(b)	Determine the principal stresses and direction cosines of any one principal stress for the following state of stresses.	**07**

$$\begin{bmatrix} 2 & -1 & 4 \\ -1 & 4 & 0 \\ 4 & 0 & 3 \end{bmatrix} \text{MPa}$$

OR

Q.5	**(a)**	Draw the neat sketch for the displacement of an element. Also, derive the equation for various strains in Polar Coordinate System.	**07**
	(b)	Derive equation of buckling load & deformation for the column with one end free & other fixed which produces structural instability.	**07**

****