

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 $\sigma_x = -210$ MPa (C), $\sigma_y = 0$ & $\tau_{xy} = 175$ 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: $\nabla^2 (\phi/2G\theta) = \nabla^2 (sz/p) = -1$. **07**
- Q.3** (a) Determine the principal stresses using Cardan’s method and the direction cosines of principal stresses. Normal stresses: $\sigma_{xx} = 300$ MPa, $\sigma_{yy} = -100$ MPa, $\sigma_{zz} = -120$ MPa, and Shear stresses: $\tau_{xy} = 10$ MPa, $\tau_{yz} = 40$ MPa, $\tau_{zx} = -25$ 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. **07**
 $\sigma_x = 1.31x^3 + 0.0512y$, $\sigma_y = 1.1x^2 + 13.2$ & $\tau_{xy} = 2.7z + 2.2y^2$. Assume $E = 210$ GPa & Poisson’s ratio $\nu = 0.17$.
- (b) Derive the following equation with usual notations: **07**
 $\epsilon_\theta = \frac{1}{2}(\epsilon_x + \epsilon_y) + \frac{1}{2}(\epsilon_x - \epsilon_y) \cos 2\theta + \epsilon_{xy} \sin 2\theta$

- 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**
