

**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:  $\nabla^2 (\phi/2G\theta) = \nabla^2 (sz/p) = -1$ . **07**

- Q.2** (a) Find the principal stresses using Cardan's method and the direction cosines of principal stresses. **07**  
 Normal stresses:  $\sigma_{xx} = 600$  MPa,  $\sigma_{yy} = -140$  MPa,  $\sigma_{zz} = -100$  MPa, and Shear stresses:  $\tau_{xy} = 20$  MPa,  $\tau_{yz} = 45$  MPa,  $\tau_{zx} = -30$  MPa,
- (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  $\rho$ , rotating about the center with angular velocity  $\omega$ . **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. **07**

$$\begin{bmatrix} 9 & 6 & 3 \\ 6 & 5 & 2 \\ 3 & 2 & 4 \end{bmatrix} \text{ MPa}$$

- 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  $\sigma_x = -100$  MPa (C),  $\sigma_y = 0$  &  $\tau_{xy} = 100$  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**  
 $\epsilon_{\theta} = \frac{1}{2} (\epsilon_x + \epsilon_y) + \frac{1}{2} (\epsilon_x - \epsilon_y) \cos 2\theta + \epsilon_{xy} \sin 2\theta$
- (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**  
 $\sigma_x = 1.31x^3 + 0.0512y$ ,  $\sigma_y = 1.1x^2 + 13.2$  &  $\tau_{xy} = 2.7z + 2.2y^2$ . 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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