Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – SUMMER • 2014

Subject code: 711503N **Date: 19-06-2014**

Subject Name: Advanced Solid Mechanics

Time: 02:30 pm - 05:00 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 ñOctahedral Planesò and derive the expressions for normal stresses and shear stresses for such planes. **07**

(b) Elaborate soap film bubble analogy and derive the following equation with usual notations: ∇2 (ű/2Gd) = ∇2 (sz/p) = ï 1. **07**

Q.2 **(a)** Draw the neat sketch for an element subjected to body forces, radial stresses, transverse stresses and shear stresses. Also, explain the basic differential equations of equilibrium in 2-D Polar Coordinate System. (no need for derivation) **07**

(b) Draw the neat sketch for the displacement of an element. Also, explain the equation for various strains in Polar Coordinate System with its derivation. **07**

OR

(b) Explain the generalized Hookeôs law. Derive the stress-strain relationship for Isotropic materials and the relationship between the elastic constants. **07**

Q.3 **(a)** Derive the equation of curved beams subjected to bending moment. Also, give various boundary conditions for the same. **07**

(b) Find the principal stresses using CARDANôs method and the direction cosines of principal stresses. **07**

Normal stresses: ůxx = 700 MPa, ůyy = ï 150 MPa, ůzz = ï 120 MPa, and Shear stresses: Ű́xy = 25 MPa, Ű́yz = 40 MPa, Ű́zx = ï 30 MPa,

OR

Q.3 **(a)** For a solid circular plate of small uniform thickness, material density ɟ, rotating about the center with angular velocity ɤ, derive the expression for radial and tangential stress. **07**

(b) Find 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)** What is the concept of stability of structures? Give basis of stability of analysis for a slender straight column as well as column initially bent. **07**

(b) A solid circular shaft up of Cast Iron is 2.2 m long & fixed at one end is subjected to a torque T = 700 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 CI is 160 MPa. **07**

OR

Q.4 **(a)** Discuss effect of transverse shear on buckling of the beam & derive equation of critical load for the same. **07**

(b) Derive equation of buckling load & deformation for the column with one end free & other fixed which produces structural instability. **07**

Q.5 **(a)** At a point in a strained ductile material, the biaxial state of stresses are acting as ůx = -150 MPa (C), ůy = 0 & Ű́xy = 150 MPa. If yield strength of the material is 260 MPa, check whether the material is safe using maximum shear stress theory and/or maximum distortion energy theory. **07**

(b) Give characteristics of Airyôs stress function. Is ū = A (y^4 ï $3x^2y^2$) representing Airyôs stress function? Here, A is a constant. **07**

OR

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

Ű́ď = ½ (Ůx + Ůy) + ½ (Ůx - Ůy) Cos 2ď + Ű́xy Sin 2ď

(b) Given the following stress field in MPa : **07**

ůx= $1.38x^3$ + 0.0552y, ůy =1.104 x^2 + 13.8 & Ű́xy = 2.76z + $2.208y^2$. Calculate strain at a point (3, 5, 2). Assume E= 220 GPa & Poissonôs ratio з = 0.18.

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