Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. IST Semester–Remedial Examination – July- 2011

Subject code: 711503

Subject Name: Advanced Solid Mechanics

Date:11/07/2011 **Time: 10:30 am – 01:00 pm**

Total Marks: 60

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Drawing neat sketch for the element subjected to 3-D state of Cartesian stresses along with body forces, derive any one basic differential equation of equilibrium and write the other two equations. Also, write the solutions of stresses in terms of Airy's stress function for any 2-D state of stresses. **06**

(b) Define "Octahedral Planes" and derive the expressions for normal stresses and shear stresses for such planes. **06**

Q.2 **(a)** Explain soap film bubble analogy and derive the following equation with usual notations: **06**

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

Comment on usefulness of membrane analogy for solution of complex problems in torsion.

(b) Drawing neat sketch for the displacement of an element, derive the equation for various strain in Polar Coordinate System. **06**

OR

(b) Derive equation of curved beams subjected to bending moment. Also give various boundary conditions for the same. **06**

Q.3 **(a)** In an infinitely long and wide plate having width: **2b,** a circular hole of very small radius: **a** is made at the centre of plate. The plate is subjected to a uni-axial stress along its length. Prove that the stress changes the nature along the inner circumference of the hole. Also, prove that the maximum stress is three times the axial stress. **06**

(b) Find the principal stresses using CARDAN's method and direction cosines of any one principal stress for the following state of stresses. **06**

Normal stresses : $\sigma_x = 600$ MPa, $\sigma_y = 500$ MPa, $\sigma_z = -400$ MPa

Shear Stresses : $\tau_{xy} = 150$ MPa, $\tau_{yz} = 250$ MPa, $\tau_{zx} = 200$ MPa

OR

Q.3 **(a)** For a solid circular disk of small uniform thickness, material density: ρ, rotating about the center with angular velocity: ω, derive the expressions for radial stress and tangential stress. **06**

(b) Derive the following equation with usual notations: **06**

$\epsilon_\theta = \frac{1}{2} (\epsilon_x + \epsilon_y) + \frac{1}{2} (\epsilon_x - \epsilon_y) \text{Cos } 2\theta + \epsilon_{xy} \text{ Sin } 2\theta$

Q.4 **(a)** Give characteristics of Airy's stress function. Is $\Phi = A (y^4 - 3x^2y^2)$ representing Airy's stress function? Here, A is a constant. **06**

(b) Given the following stress field in MPa **06**

$\sigma_x = 1.38x^3 + 0.0552y$, $\sigma_y = 1.104 x^2 + 13.8$ & $\tau_{xy} = 2.76z + 2.208y^2$

Calculate strain at a point (4,5,2). Assume E= 210 GPa & Poisson's ratio ν = 0.20.

OR

Q.4 **(a)** For axis-symmetrical stress distribution in Polar Coordinate System, constant B of Airy's stress function: $\Phi = A \ln r + B r^2 \ln r + Cr^2 + D$ is required to be zero. Why? Also explain the same. **06**

(b) At a point in a strained ductile material, the biaxial state of stresses are acting as $\sigma_x = -120$ MPa (C), $\sigma_y = 0$ & $\tau_{xy} = 120$ MPa. If yield strength of the material is 270 MPa, check whether the material is safe using maximum shear stress theory and/or maximum distortion energy theory. **06**

Q.5 **(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. **06**

(b) A rectangular strain gauge rosette gave the following reading at a point: **06**

$$\varepsilon_0 = 1240 \times 10^{-6},\ \varepsilon_{45} = 400 \times 10^{-6},\ \varepsilon_{90} = 200 \times 10^{-6}.$$

Determine the magnitudes of Principal strains and stresses. Take E = 210 GPa and $\nu = 0.3$

OR

Q.5 **(a)** Discuss effect of transverse shear on buckling of the beam & derive equation of critical load for the same. **06**

(b) Derive equation of buckling load & deformation for the column with one end hinged & other fixed which produces structural instability. **06**

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