Seat No.: ________ *Enrolment No.*___________

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – WINTER • 2013

Subject code: 711503N **Date: 03-01-2014**

Subject Name: Advanced Solid Mechanics

Time: 10.30 am – 01.00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full mark.**
4. **Draw neat diagrams wherever necessary.**

Q.1 **(a)** Define "Octahedral Planes" and derive the expressions for normal stresses and shear stresses for such planes. **07**

(b) State assumptions made in Theory of Elasticity and explain "Generalized Hooke's Law". **07**

Q.2 **(a)** For a solid circular plate of small uniform thickness, material density **ρ**, rotating about the center with angular velocity **ω**, derive the expression for radial and tangential stress. **07**

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

OR

(b) For the following state of stresses, find the principal stresses using CARDAN's method and direction cosines of any one principal stress. **07**

Normal stresses : $\sigma_{xx} = 600$ MPa , $\sigma_{yy} = 500$ MPa , $\sigma_{zz} = -400$ MPa

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

Q.3 **(a)** Derive Airy's stress function in Polar Co-ordinate system for an Axis-symmetric stress distribution. **07**

(b) Find the linear strains: ε_{xx} & ε_{yy} and shear strain: γ_{xy} for the linear strains measured by the strain gauges in the direction as ε_{25° = 90 x 10^{-3} (tensile), ε_{70° = -20 x 10^{-3} (comp.) and ε_{140° = 30 x 10^{-3} (tensile). **07**

Also calculate the state of stresses. Take E = 200 GPa and ν = 0.25.

OR

Q.3 **(a)** For axis-symmetrical stress distribution in Polar Coordinate System, constant **B** of Airy's stress function: $\Phi = A \ln r + B r^2 \ln r + C r^2 + D$ is required to be zero. Why? Also explain the same. **07**

(b) Derive the following equation with usual notations: **07**

$$\varepsilon_\theta = \frac{1}{2}(\varepsilon_x + \varepsilon_y) + \frac{1}{2}(\varepsilon_x - \varepsilon_y)\cos 2\theta + \varepsilon_{xy}\sin 2\theta$$

Q.4 **(a)** Explain soap film bubble analogy and derive the following equation with usual notations: **07**

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

(b) The biaxial state of stresses is acting at a point in a strained ductile material as σ_x = -120 Mpa (Compressive), $\sigma_y = 0$ and $\tau_{xy} = 120$ 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. **07**

OR

Q.4 **(a)** Drawing neat sketch for an element subjected to body forces, radial stresses, transverse stresses and shear stresses, derive the basic differential equations of equilibrium in 2-D Polar Coordinate System. **07**

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

$\sigma_x = 0.345x^3 + 0.0138y$, $\sigma_y = 0.276x^2 + 3.45$ & $\tau_{xy} = 0.69z + 0.552y^2$

Calculate strain at a point (2,2,1). Assume E= 200 GPa and ν = 0.25.

Q.5 **(a)** Explain the effect of transverse shear on buckling of the beam & derive equation of critical load for the same. **07**

(b) Using finite difference approach, derive equation of buckling load & deformation for the column with both ends hinged. **07**

OR

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. **07**

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

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