Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – WINTER 2012

Subject code: 711503N **Date: 12-01-2013**

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)** State the important observation made in equilibrium approach and derive its general equation to get critical load for end condition as both end fixed. **07**

(b) Discuss energy approach for stability of columns & derive the general equation to get critical load P using energy approach. ($P_{cr}=\beta l$, $\Delta v=\Delta T$) **07**

Q.2 **(a)** Derive the basic differential equation for equilibrium in Cartesian co-ordinate system. **07**

(b) Is the following 2-D state of plane strain is possible? Check. **07**

$\varepsilon_X = 7x^2y - 3x^2 + 7xy^2 + 9$

$\varepsilon_Y = 9x^3 + 8xy + 2x^2 + 8$

$\varepsilon_{XY} = ½\, \gamma_{XY} = 17x^2y + 2xy + 15$

OR

(b) Show that the following 2-D state of stresses without body forces is in equilibrium: **07**

$\sigma_X = 3x^2 + 9xy + 10y^2$ $\sigma_Y = 7x^2 + 8xy + 3y^2$ $\tau_{XY} = -4x^2 - 6xy - 4.5y^2$

Q.3 **(a)** Derive the basic differential equation for beam column subjected to axial compressive force P and distributed load of intensity Q. **07**

(b) Discuss the principle of imperfection approach for stability of column and derive the equation for critical load for end condition as one end fixed and one end free. **07**

OR

Q.3 **(a)** Define co-efficient of end restrained using beam column theory. Derive basic equations for statically indeterminate beam column with elastic restraints. **07**

(b) Derive the standard equation for bucking of frames to get critical load. Use symmetrical bucking. **07**

Q.4 **(a)** Explain Airy's stress function for a circular plate with hole. **10**

(b) A cylinder 100 mm Φ (internal) is subjected to an internal pressure 60 MPa. There is no external pressure. If the allowable stress in the metal is 160 Mpa, calculate external diameter. **04**

OR

Q.4 **(a)** For the following state of stresses, find the principal stresses. **07**

Normal stresses: $\sigma_{xx} = 450$ MPa, $\sigma_{yy} = -90$ MPa, $\sigma_{zz} = -50$ MPa, and

Shear stresses: $\tau_{xy} = 90$ MPa, $\tau_{yz} = -50$ MPa, $\tau_{zx} = 20$ MPa,

(b) Locate principal planes and obtain principal strains at point (3, –1) for the following system of strains: **07**

$\varepsilon_X = x^3y + 5x^2 + 3x^3 + 2y^3 + 12$

$\varepsilon_Y = x^2 + 3y^2 + 2x^4 + 5y^3$

$\gamma_{XY} = 3x^2 + y^2 - ½\, x^4 + y^4$ where strains are in nm and x and y in mm.

Q.5 **(a)** Find the linear strains: ε_{xx}, ε_{yy} and shear strain: γ_{xy}, as well as state of stresses: σ_{xx}, σ_{yy} and shear strain: τ_{xy}, if the linear strains measured by the strain gauges in the direction are $\varepsilon_{35^\circ} = 400\text{x}10^{-6}$ (Compressive), $\varepsilon_{70^\circ} = 750\text{x}10^{-6}$ (Compressive) and $\varepsilon_{130^\circ} = 300\text{x}10^{-6}$ (Tensile). **07**

(b) State the differential equation for the case of non-conservative forces for column with one end fixed and one end free condition using static criteria of stability.

OR

Q.5 **(a)** Enlist the assumptions involved in the theory of torsion of a long bar, subjected to twisting moment: T. Also, write steps in deriving the equation: $\nabla^2 (\phi) = -2G\theta$ with usual notations **07**

(b) Derive general equation of deflection to study initial effect of curvature using imperfection approach. **07**

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