

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**

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

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

$$\varepsilon_{xy} = \frac{1}{2} \gamma_{xy} = 17x^2y + 2xy + 15$$

OR

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

$$\sigma_x = 3x^2 + 9xy + 10y^2 \quad \sigma_y = 7x^2 + 8xy + 3y^2 \quad \tau_{xy} = -4x^2 - 6xy - 4.5y^2$$

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 buckling of frames to get critical load. Use symmetrical buckling. **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**

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

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

$$\gamma_{xy} = 3x^2 + y^2 - \frac{1}{2}x^4 + y^4 \text{ where strains are in nm and x and y in mm.}$$

- 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 $\epsilon_{35^\circ} = 400 \times 10^{-6}$ (Compressive), $\epsilon_{70^\circ} = 750 \times 10^{-6}$ (Compressive) and $\epsilon_{130^\circ} = 300 \times 10^{-6}$ (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**
