Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

ME Semester – I (civil-CASAD) Examination Winter – 2014

Subject code: 711503 **Date : 03-12-2014**

Subject Name: Advanced Solid Mechanics

Time: 10:30 to 1:00 AM **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)** Derive the basic differential equation for equilibrium in Cartesian co-ordinate system. **07**

(b) Discuss energy approach for stability of columns & derive the general equation to get critical load P using energy approach. (P_{cr}=ƀl, qpv=qpT) **07**

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

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

(b) Derive the equation $\nabla^4\phi = 0$ for polar co-ordinate system. **07**

OR

(b) Discuss energy approach for stability of column and derives its general equation to get critical load for end condition as one fixed and one end free. **07**

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) For the curved beam subjected to moment: M = 300 kJ, internal & external radii: a = 360 mm & b = 200 mm respectively, calculate radial and transverse stresses at inner, outer and every quarter thickness points and plot their variations using the following equations with usual notations: **07**

Radial stress:

$\sigma_r =$ ï $^{4M}/_N [a^2b^2/r^2 \ln(b/a) + b^2 \ln(r/b) + a^2 \ln(a/r)]$

Tangential stress:

$\sigma_\theta =$ ï $^{4M}/_N [$ï $a^2b^2/r^2 \ln(b/a) + b^2 \ln(r/b) + a^2 \ln(a/r) + b^2$ ï $a^2]$

Here; $N = (b^2$ ï $a^2)^2$ ï $4a^2b^2 [\ln(b/a)]^2$

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

(b) A cylinder 100 mm ū (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: σ_{xx} = 100 MPa, σ_{yy} = 100 MPa, σ_{zz} = 100 MPa, and
Shear stresses: τ_{xy} = 0(zero) MPa, τ_{yz} = 0 (zero) MPa, τ_{zx} = 0 (zero) MPa,

(b) Locate principal planes and obtain principal strains at point (4, ï 2) for the following system of strains: **07**
$\varepsilon_X = x^3y + 5x^2 + 3x^3 + 2y^2 + 12$
$\varepsilon_Y = x^2 + 3y^2 + 2x^3 + 5y^3$
$\gamma_{XY} = 3x^2 + y^2$ ï 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 ε_{35° = 400x10$^{ï 6}$ (Compressive), ε_{70° = 750x10$^{ï 6}$ (Compressive) and ε_{130° = 300x10$^{ï 6}$ (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: $\nabla^2(\phi) = ï\ 2G\theta$ with usual notations **07**

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