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. ($P_{cr}$=ƃl, qpv=qpT) | **07** |
| **Q.2** | **(a)** | Show that the following 2-D state of stresses without body forces is in equilibrium: $\sigma_X = 3x^2 + 9xy + 10y^2$ $\sigma_Y = 7x^2 + 8xy + 3y^2$ $\tau_{XY}$ = ï 4x² ï 6xy ï 4.5y² | **07** |
| | **(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: **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 4 $a^2b^2$ [ln (b/a)]$^2$ | **07** |
| **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: $\sigma_{xx}$ = 100 MPa, $\sigma_{yy}$ = 100 MPa, $\sigma_{zz}$ = 100 MPa, and

Shear stresses: $\tau_{xy}$ = 0(zero) MPa, $\tau_{yz}$ = 0 (zero) MPa, $\tau_{zx}$ = 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: $\varepsilon_{xx}$, $\varepsilon_{yy}$ and shear strain: $\gamma_{xy}$, as well as state of stresses: $\sigma_{xx}$, $\sigma_{yy}$ and shear strain: $\tau_{xy}$, if the linear strains measured by the strain gauges in the direction are $\varepsilon_{35^\circ}$ = 400x10$^{ï 6}$ (Compressive), $\varepsilon_{70^\circ}$ = 750x10$^{ï 6}$ (Compressive) and $\varepsilon_{130^\circ}$ = 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**