Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER I (NEW) EXAMINATION – SUMMER 2017

Subject code: 2712010 **Date:11/05/2017**

Subject Name: Advanced Solid Mechanics

Time:02:30 p.m. to 05:00 p.m. **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 basic differential equation in Cartesian co-ordinate system. **07**

(b) Derive strain-displacement relation in polar co-ordinate system. **07**

Q.2 **(a)** Check whether the following 2-D state of stresses without body forces is in equilibrium or not. $\sigma_X = 3x^2 + 9xy - 8y^2$ $\sigma_Y = 2x^2 + 5xy + 3y$ $\tau_{XY} = -\frac{1}{2}x^2 - 6xy - 3y^2$ **04**

(b) For the following state of stresses, find the principal stresses and the direction cosines of any **ONE** principal stress. Normal stresses: σ_{xx}=300 MPa, σ_{yy} = 200 MPa, σ_{zz} = 100 MPa, and Shear stresses: τ_{xy} = 50 MPa, τ_{yz} = 50 MPa, τ_{zx} = 50 MPa, **10**

OR

(b) Derive basic differential equation of equilibrium in polar co-ordinate system. **10**

Q.3 **(a)** Explain about the radial and tangential stress induced in the curved bar due to pure bending. **07**

(b) For the curved beam subjected to moment: M = 150 kJ, internal & external radii: a = 150 mm & b = 350 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:

$\sigma_r = -\,{}^{4M}/_{N}\,[a^2b^2/r^2 \ln(b/a) + b^2 \ln(r/b) + a^2 \ln(a/r)]$

Tangential stress:

$\sigma_\theta = -\,{}^{4M}/_{N}\,[-a^2b^2/r^2 \ln(b/a) + b^2 \ln(r/b) + a^2 \ln(a/r) + b^2 - a^2]$

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

OR

Q.3 **(a)** Using Swift construction, find normal and resultant shear stress on a plane whose normal has directions cosines are l = 0.342, m = 0.405 respectively w.r.t. Principal stresses: P_1 = 900 MPa (Tensile), P_2 = 200 MPa (Tensile) and P_3 = 300 MPa (Compressive). **07**

(b) Explain plane stress and plane strain problem. Also explain Generalized Hook's law. **07**

Q.4 **(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 both end fixed which produces structural instability. **07**

OR

Q.4 **(a)** Drawing neat sketch, explain the soap-bubble analogy of torsion in and derive the equation $\phi = (2\,C\,\theta\,S/p)\,z$ with usual notations. **07**

(b) Derive Airy's stress function: $\phi = A \ln r + B r^2 \ln r + Cr^2 + D$ in Polar Co-ordinate System for an Axi-symmetric stress distribution. **07**

Q.5 **(a)** Derive the equation of displacement for the column with one end hinged & other fixed in bent configuration which produces structural instability. **07**

(b) Discuss effect of transverse shear on buckling of the beam & derive equation of critical load for the same. **07**

OR

Q.5 **(a)** Derive the equation of displacement for the column, eccentrically loaded, with one end hinged & other fixed in bent configuration which produces structural instability. **07**

(b) Derive the basic equation of equilibrium for column in bent configuration subjected to **07**

dynamic force. Also explain mode shapes of buckling.