Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER–I(New course)• EXAMINATION – WINTER- 2015

Subject Code: 2714302 **Date: 02/01/2016**

Subject Name: Theory of Elasticity and plastic

Time:2:30 pm to 5:00 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)** Is the following 2-D state of plane strain is possible? Check. **07**

$\varepsilon_X = 4x^3y + 3x^2 - 13.5x^2y^2 + 18y + 4$

$\varepsilon_Y = 4xy^3 + 6x - x^2 + 3y^2 + 5$

$\varepsilon_{XY} = ½\, \gamma_{XY} = -2x^2 - 1.5y^2 - 4.5x^3y - xy + 4$

(b) Using Swift's construction, find normal and resultant shear stress on a plane whose normal has direction cosines are l=0.544, m= 0.766 and n=0.342 respectively w.r.t principal stresses p1= 650 MPa(tensile), p2=150 MPa (tensile) and p3=350 MPa (compressive). **07**

Q.2 **(a)** Derive general equation of deflection (δ) for a beam column with a concentrated load. **07**

(b) Derive general equation of deflection (y) for a beam column with continuous lateral load. **07**

OR

(b) Using trigonometry series determine the value of critical load by assuming suitable shape of curve. State the advantages of energy approach. **07**

Q.3 **(a)** Discuss imperfection approach and state the principle of imperfection for stability of column. **07**

(b) Describe theory of Von Mises for yield criteria. **07**

OR

Q.3 **(a)** Derive the following equation with usual notations **07**

$\varepsilon_\theta = ½(\varepsilon_x + \varepsilon_y) + ½\,(\varepsilon_x - \varepsilon_y)\cos 2\theta + \varepsilon_{xy}\sin 2\theta$

(b) Obtain principal strains at point (2,1) for the following system of strain **07**

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

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

$\gamma_{xy} = x^2 + 3y^2 - x^3 + 2y^4$

Q.4 **(a)** For the following state of stresses, find the principal stresses and the direction cosines of any **ONE** principal stress. **10**

Normal stresses: $\sigma_{xx} = 400$ MPa, $\sigma_{yy} = 200$ MPa, $\sigma_{zz} = 300$ MPa, and

Shear stresses: $\tau_{xy} = 80$ MPa, $\tau_{yz} = 10$ MPa, $\tau_{zx} = -60$ MPa,

(b) Write the compatibility equation for 2-D strains. From which derive the equation $\nabla^4\phi = 0$, where ϕ represents Airy's stress function. **04**

OR

Q.4 **(a)** 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:

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

If, moment: M = 150 kJ, internal & external radii: a = 200 mm & b = 300 mm respectively. Here; $N = (b^2 - a^2)^2 - 4\,a^2b^2\,[\ln(b/a)]^2$

(b) Derive basic differential equation of equilibrium in Cartesian co-ordinate system. **07**

Q.5 **(a)** A cylinder 120 mmΦ (external) is subjected to an internal pressure of 50 MPa. There is no external pressure. If the allowable stress in the metal is 120 MPa calculate internal diameter. **07**

(b) Find the linear strains: ε_{xx}, ε_{yy} and shear strain: γ_{xy}, if the linear strains measured by the strain gauges in the direction are $\varepsilon_{20°} = 250\text{x}10^{-6}$ (Tensile), $\varepsilon_{80°} = 300\text{x}10^{-6}$ (Compressive) and $\varepsilon_{140°} = 150\text{x}10^{-6}$ (Tensile). Also, calculate the state of stresses. Take $E=2\text{x}10^5$ N/mm² & $\mu=0.25$. **07**

OR

Q.5 **(a)** Discuss in details dynamic or vibration approach. Discuss any one structural application. **07**

(b) 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**