Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code: 2712010 **Date: 04/01/2016**

Subject Name: Advanced Solid Mechanics

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)** Check whether the following function Ø is a valid Airy's stress function over the domain $0 \le x \le l, \quad -d \le y \le +d$ **07**

$$\emptyset = \frac{q}{40\,d^3}\left\{\begin{matrix} 5\,x^2y^3 & -10\,l\,xy^3 & +30d^2l\,xy & +2d^2y^3 \\ -10d^3x^2 & -\,y^5 & -15d^2x^2y & +5l^2y^3 \end{matrix}\right\}$$

(b) Find the stresses induced if the function Ø in Q.1(a) above is used to specify the stress distribution for a 2-D problem of elasticity in Cartesian coordinates. Show the variation of stresses **07**

Q.2 **(a)** What problem is solved by above function Ø used in Q.1(a & b)? Is there any inconsistency observed? **07**

(b) A thick cylinder of inner radius 150mm and thickness 80mm carries radial pressure of intensity 3.04 N/mm^2 and 0.52 N/mm^2 on the inner and outer surface respectively. Find the major principal strain developed in the cylinder and its position. Take E = 2 x 10^5 MPa, $\nu = 0.3$ **07**

OR

(b) Derive the Laplacian form of stress compatibility equation in x-y plane ignoring body forces **07**

Q.3 **(a)** Find intensities of principal stresses induced at a strained point, state of stress at which is as given below **07**

$\sigma_x = 83.65$ MPa, $\tau_{xy} = 72$ MPa

$\sigma_y = -106.48$ MPa, $\tau_{yz} = 0$

$\sigma_z = 49.14$ MPa, $\tau_{zx} = 0$

(b) Find constraints to be satisfied by constants A, B, C such that the following displacement field produces a system in equilibrium **07**

$u = Azx$, $v = 0$ and $w = Bx^2 + Cy^2$

u, v and w are displacements parallel to axes x, y and z respectively in a Cartesian frame. Ignore body forces

OR

Q.3 **(a)** Using finite difference method find buckling load of a prismatic fixed-hinged column. Divide the column in 04 equal parts **07**

(b) Find the buckling load for a frame braced laterally with a view to produce a symmetric buckling mode. The frame has its base fixed at 'A' and 'D'. Lengths and 'EI' of vertical columns AB, CD and horizontal beam BC are same **07**

Q.4 **(a)** What do you understand by warping of a shaft subject to pure torsion? Show distinctive zones of warp in solid prismatic shafts of following cross sections. Also show, approximately, contours for warp produced **07**

i. Elliptical cross-section

ii. C/s as an equilateral triangle

iii. Square cross section

iv. Rectangular cross section with d/b = 2.05

v. Rectangular cross section with d/b = 1.27

(b) A simply supported beam column of length '*l*' carries u.d.l. of intensity 'w' on entire length. In addition it carries an axial compressive force 'P' which is 75% of its crippling load. Estimate the increase in the maximum BM at centre of beam column compared with that of a corresponding simply supported beam carrying only u.d.l. **07**

OR

Q.4 **(a)** Write a note on – Plane strain condition **07**

(b) A column hinged at both ends is bent initially to form a sine curve. Find the equation to deflected profile of the column if it is to carry an axial compressive force 'P' **07**

Q.5 **(a)** Find explicitly the unit angle of twist, in terms of applied uniform torque 'T', in a prismatic solid shaft which has cross section in the form of an equilateral triangle of side 'a' using stress function approach having vertices A($-\frac{a}{2}$, 0), B(0 , $\frac{\sqrt{3}}{2}a$) and C($+\frac{a}{2}$, 0) **07**

(b) Enlist steps you will follow to find the buckling load for a single bay single storey portal frame fixed at base using stiffness matrix method. Consider all members to have same length and flexural rigidity **07**

OR

Q.5 **(a)** An infinitely large plate carrying axial tension 'σ_x' along the axis of plate, has a hole of radius 'a'. Find the stresses σ_r and σ_θ at point (2a, $\pi/3$) in polar coordinate system having centre of hole as origin. Angles 'θ' are measured in radian from the longitudinal axis x-x of the plate. **07**

(b) Find the buckling load for a cantilever (fixed at base – free at top) column using classical method **07**

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