Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER I (OLD) – • EXAMINATION – SUMMER 2016

Subject Code: 711503N **Date:18/05/2016**

Subject Name: Advanced Solid Mechanics

Time:02:30 pm to 05:00 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)** A thick cylinder of inner radius 225mm and thickness 120mm carries radial suction of intensity 2.1N/mm^2 and pressure of intensity 0.53 N/mm^2 on the inner and outer surface respectively. Find the maximum shear strain developed in the cylinder and its position. Take E = 2 x 10^5 MPa, ν = 0.3 **07**

(b) Find the body forces, required to keep the stress system in equilibrium, at point (3, -1, 2) **07**

$$\sigma_x = x^2\left(3z - \frac{5x}{3}\right), \qquad \sigma_y = -y^2\left(5x - \frac{2y}{3}\right)$$
$$\sigma_z = z^2(2y + z), \qquad \tau_{xy} = -5x^2y$$
$$\tau_{yz} = -2y^2z, \qquad \tau_{zx} = -3z^2x$$

Q.2 **(a)** Find the stress distribution along perpendicular bisector of base 'MP', in a prismatic solid shaft subject to uniform torque 'T', which has cross section in the form of an isosceles triangle having vertices M($-\frac{a}{2}$, 0), N(0 , $\frac{a}{2}$) and P(+$\frac{a}{2}$, 0) using stress function approach **07**

(b) A point in a strained material has direct strains ε_x along axis x, ε_y along axis y and shear strain γ_{xy} in plane xy. Find the state of strain along a set of mutually perpendicular axes x'-x' and y'-y' passing through the same point if axis x'-x' makes an angle β with x-x axis. **07**

OR

(b) Find magnitudes of principal strains induced at a point in a strained material, state of strain at which is as given below **07**

$\varepsilon_x = 48.5 \times 10^{-6}$, $\gamma_{xy} = 0$

$\varepsilon_y = -73 \times 10^{-6}$, $\gamma_{yz} = -90 \times 10^{-6}$

$\varepsilon_z = 120.6 \times 10^{-6}$, $\gamma_{zx} = 0$

Q.3 **(a)** Find buckling load for a hinged-hinged column using classical method. What change in the crippling load carrying capacity you expect if the same column were also restrained, laterally, to produce a zero deflection (transverse displacement) at its centre? Justify your statement **07**

(b) Derive an expression for the normal stress carried by an oblique plane passing through a point in a strained material for a 3 – D problem of elasticity **07**

OR

Q.3 **(a)** Find the strains induced in 'r' and 'θ' direction if the displacements 'u' and 'v' along the same are given by **07**

$$u = 7\,r\cos\theta + \frac{5}{2}\,r\sin\theta$$

$$v = 4\,r - \frac{5}{2}\,r\cos\theta + 7\,r\sin\theta$$

(b) Write a note on – Membrane analogy **07**

Q.4 **(a)** 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 1/4th of its buckling load. Estimate the increase in the maximum slope at the support of beam column compared with that of a corresponding simply supported beam carrying only u.d.l. **07**

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

OR

Q.4 **(a)** A column carrying an axial compressive force 'P' and initially bent in the form a sine curve is hinged at both ends. Find the equation to deflected profile of the column. **07**

(b) What do you understand by stress concentration? An infinitely large plate loaded in unidirectional uniform tension has a small hole, having its centre as origin, punched through it. Suggest appropriate stress function. Find expressions for σ_r , σ_θ , $\tau_{r\theta}$ at a point (r, θ) and enlist boundary conditions to evaluate unknowns. **07**

Q.5 **(a)** Derive equations to find the buckling load for a single bay single storeyed portal frame fixed at base having all members of same length and same 'EI' **07**

(b) Derive necessary boundary condition, in its most general form, to be satisfied by a chosen warping function for a solid prismatic shaft of non-circular section subject to torque. Draw neat sketches showing the variation of warp for following sections **07**

i. Square
ii. Rectangle having d/b = 1.3

OR

Q.5 **(a)** A stress function, used to find stresses produced by a compressive point load 'P' acting normal to the boundary of a semi-infinite medium at any point (r, θ), is given by **07**

$$\emptyset = \frac{P}{\pi}\{49 - r[4cos\theta - (1-\theta)sin\theta]\}$$

where 'r' is the distance of point measured from the point of application of the load along any line making an angle 'θ' with line of action of load. Find stresses induced. Offer comments on the results obtained.

(b) Find the critical load for a fixed – hinged prismatic column **07**

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