Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

ME Semester –I Examination Feb. - 2012

Subject code: 714303N **Date: 17/02/2012**
Subject Name: Theory of Elasticity & Plasticity
Time: 10.30 am – 01.00 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)**	Explain the concept of stability & State the various stability criteria used for generating alternative configurations in structural analysis. Also state the types of failure associated with structures.	**07**
	(b)	Explain Equilibrium approach or Euler approach & derive the general equation to get critical load for end condition as one end fixed and one end free. State the important observation made in Equilibrium approach.	**07**
Q.2	**(a)**	Check the equilibrium of the following 2-D state of stresses without body forces $\sigma x= 4x^2+3xy-5y^2$ $\sigma y= x^2+2xy+4y^2$ $\tau xy= -x^2-8xy-(3/2)y^2$	**07**
	(b)	Using Swift's construction, find normal and resultant shear stress on a plane whose normal has direction cosines are l=0.848, m= 0.342 and n=0.405 respectively w.r.t principal stresses p1= 500 MPa(tensile), p2=150 MPa (tensile) and p3=400 MPa (compressive).	**07**
		OR	
	(b)	Derive the following equation with usual notations : $\varepsilon_\theta = \varepsilon_x\cos^2\theta + \varepsilon_y\sin^2\theta + \varepsilon_{xy}\sin 2\theta$	**07**
Q.3	**(a)**	Discuss imperfection approach and state the principle of imperfection for stability of column. State the differential equation for the case of non-conservative forces for column with one end fixed & one end free using Dynamic criteria of stability.	**07**
	(b)	Using beam-column theory derive basic equations for a beam of length 'l' resting on two simple supports carrying several concentrated lateral loads 'Q_1 ,Q_2--------Q_n' at some known distance from right hand support.	**07**
		OR	
	(a)	Derive the standard equation for bucking of frames to get critical load. Use symmetrical bucking.	**07**
	(b)	Using beam column theory derive standard equation for a beam of length l resting on two simple supports (one end hinged and one end roller) carrying continuous lateral load of intensity q over the entire span.	**07**
Q.4	**(a)**	Find the linear strains: ε_{xx}, ε_{yy} and shear strain: $\gamma_{xy,}$ if the linear strains measured by the strain gauges in the direction are $\varepsilon_{15°} = 130\text{x}10^{-6}$ (Tensile), $\varepsilon_{65°} = 665\text{x}10^{-6}$ (Compressive) and $\varepsilon_{125°} = 271\text{x}10^{-6}$ (Tensile). Also, calculate the state of stresses.	**07**
	(b)	Derive the strain displacement relation in Cartesian co-ordinate system.	**07**
		OR	
Q.4	**(a)**	Derive Airy's stress function: $\boldsymbol{\phi = A \ln r + B r^2 \ln r + Cr^2 + D}$ in Polar Co-ordinate System for an Axi-symmetric stress distribution.	**07**
	(b)	Enlist the assumptions involved in the theory of torsion of a long bar,	**07**

		subjected to twisting moment: T. Also, write steps in deriving the equation: $\nabla^2 (\phi) = -2G\theta$ with usual notations	
Q.5	**(a)**	Discuss in brief the importance of Modulus of Elasticity 'E' and its effect on various end conditions of columns. Explain various empirical formulas for column design using imperfection approach: (i) Rankine Gorden formula (ii) AISC (iii) Straight line formula	**07**
	(b)	For the curved beam subjected to moment: M = 600 kJ, internal & external radii: a = 300 mm & b = 500 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:** $\sigma_r = -\,{}^{4M}/_{N}\,[a^2b^2/r^2 \ln (b/a) + b^2 \ln (r/b) + a^2 \ln (a/r)]$ **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; $N = (b^2 - a^2)^2 - 4\,a^2b^2\,[\ln (b/a)]^2$	**07**
		OR	
Q.5	**(a)**	Discuss energy approach for stability of columns & derive the general equation to get critical load P using energy approach. ($P_{cr}=\beta l$, $\Delta v=\Delta T$)	**07**
	(b)	An elastic body under the action of external forces has displacement field given by $\delta = (3x^2)\,\mathbf{i} - (zy)\,\mathbf{j} + (x^2z - y)\,\mathbf{k}$ in nm where x, y and z are expressed in mm. Determine all the strain components at (1, –2, 1).	**07**

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