Ref. No. : Ex/CE/5/T/407/2019

Name of the Examinations: BACHELOR OF ENGINEERING (CIVIL ENGINEERING) FOURTH YEAR SECOND SEMESTER - 2019

Subject : THEORY OF STRUCTURES-IV Time : Three Hours Full Marks : 100

Instructions: Answer any four questions.

Question 1

a) Develop the Lagrangian based interpolation functions or shape functions for a 4-node one dimensional finite element. (07)

b) Develop the relationship to express Young's Modulus (E), Poisson's ratio (ν) and Shear modulus (G) in terms of Lame's Parameter. (09)

c) The strain tensor at a point in a body is given by

$$\begin{bmatrix} 12 & 3 & 4 \\ 3 & 8 & -4 \\ 4 & -4 & 18 \end{bmatrix} x10^{-3}$$

Determine the normal and the shear strain on a plane whose direction cosines with respect to the coordinate direction are given by l = m = n = $1/\sqrt{3}$. (09)

Question 2

a) Develop the moment - curvature relationship (M_x, M_y, M_{xy}) for a laterally loaded plate undergoing small deflection. (09)

b) Develop the expression for (i) Displacement (ii) Moment (iii) Edge shear (iv) Corner reaction for a simply supported plate subjected to a bi-harmonic load. (16)

Question 3

The equilibrium of a physical system is described by the following differential equation

$$-2\frac{d^2u}{dx^2} - u + x^2 = 0 \quad for\ 0 < x < 1$$

with u(0) = 0 and u(1) =2. Obtain the solution to the differential equation using **Ritz's weak variational formulation**. Compare the results with the results obtained using Collocation Method. Tabulate the results at four (4) intermediate points. (25)

Question 4

a) Obtain the strain transformation relationship for **shear strain** in two-dimension. (10)

b) Determine the orientation of the planes on which maximum shear stresses occur in a three-dimensional elastic body. (7)

c) The principal stresses acting at a point are given by σ_{11} = 15.4, σ_{22} = 12.65 and σ_{33} = 6.8 (MPa). Determine the normal and shear stresses acting upon an oblique plane whose normal is defined by the vector $u_n = 0.732u_1 + 0.521u_2 + 0.439u_3$. (8)

Question 5

a) Obtain the stress-strain constitutive relationship for plane strain problem. (6)

b) Stating clearly all the approximation based on Navier's contribution, obtain the expression for deflection and moments for a simply supported plate subjected to a uniformly distributed load q_1. Assume any other relevant data. (19)