Ref. No. : Ex/CE/5/T/407/2022

Name of the Examinations: BACHELOR OF ENGINEERING (CIVIL ENGINEERING) FOURTH YEAR SECOND SEMESTER - 2022

Subject : THEORY OF STRUCTURES-IV **Time : 3 hours** **Full Marks : 100**

Question 1 Based on Navier's Method of solution obtain the expression for deflection for a simply supported rectangular plate subjected to a patch load 'P' on a plate of size a x b. Let the size of the patch be u x v and the patch is placed with the center at a distance of η from X-axis and ξ from the Y-axis with its edges parallel to the edge of the plate. Assuming a = 5 m, b = 4 m, u = 0.5 m, v = 0.3 m, η = 1.5 m, ξ = 1.5 m and P = 1000 N find the central displacement of a **steel** plate of thickness 75 mm. Assume any other relevant data. (20 + 5)

Question 2 The axial deformation 'u' of vertical **Steel** rod is expressed by the following differential equation

$$\frac{d}{dx}\left[EA\frac{du}{dx}\right] + x = 0 \quad 0 < x < 3$$

Based on weak variational principle, obtain the displacement of the rod at the free end and two intermediate points. Assume the rod to be fixed at x = 0 and is subjected to a 5 N axial tensile force at x = 3 m. Assume the rod to be of circular cross section with diameter = 0.1 m. (25)

Question 3a Obtain the strain transformation relationship for shear strain in two-dimension. (10)

3b. For the problem given in Question 2, develop the stiffness matrix in the Finite Element sense for an element of unit length using linear interpolation function. (8)

3c. State the condition in context to the Free Edge boundary condition for laterally loaded plate. How is the condition taken care of according to Kirchhoff assumption? (7)

Question 4a Define octahedral stresses and state its significance (7)

4b Obtain the expression for Young's Modulus, Shear Modulus and Poisson's Ratio in terms of Lame's parameter for an isotropic material. (9)

4c 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 $u_n = 0.732u_1 + 0.521u_2 + 0.439u_3$. (9)