BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
Department of Civil Engineering
Second Semester 2022-23
CE F435: Introduction to FEM
Mid-Sem Exam

Duration: 90 Minutes **Max. Marks: 70**

Q5. A tapered bar of square section of length 200 mm is fixed at roof. The section of bar at roof level is 20 mm x 20 mm and at free end it is 10 mm x 10 mm. The bar is subjected to a force of 10, 000 N at free end. Using the Finite Element method, determine the axial displacement at the (i) free end, and (2) mid-point (i.e. mid-length of bar). Take $E = 2 \times 10^5\ N/mm^2$ and $\nu = 0.2$.

[20]

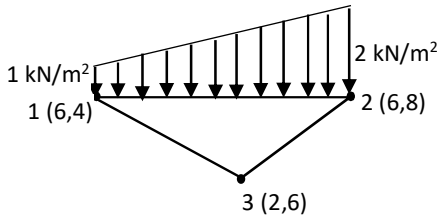
Q6. Write the interpolation functions for the four-node bar element using the Lagrange interpolation function. Show that the Lagrange interpolation functions written above may be considered shape functions for the element.

[15]

Q7. For a 3-node triangular element the displacements at nodes are u_1, v_1, u_2, v_2, u_3, v_3. Derive the strain-displacement matrix for this element.

[15]

Q8. For a triangular plate element shown in the Figure [nodal coordinates (6,4); (6,8); (2,6) and, plate thickness = 0.1 m], determine the load vector due to variable distributed load as shown in Figure.



[20]

Note: For the 3-node triangular element, the shape function for i^{th} node may be taken as

$$N_i = (1/2\Delta)[a_i + b_i x + c_i y]$$

Where, Δ = Area of Triangle, $a_1 = (x_2 y_3 - y_2 x_3)$; $a_2 = (x_3 y_1 - y_3 x_1)$; $a_3 = (x_1 y_2 - y_1 x_2)$

$$b_1 = (y_2 - y_3); \quad b_2 = (y_3 - y_1); \quad b_3 = (y_1 - y_2)$$

$$c_1 = (x_3 - x_2); \quad c_2 = (x_1 - x_3); \quad c_3 = (x_2 - x_1)$$