BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
Department of Civil Engineering
Second Semester 2022-23
CE F435: Introduction to FEM
Comprehensive Examination
Part-A (Closed Book)

Duration: 75 Min. **Max. Marks: 40**

Q1. A long steel bar is discretized into 1-D bar elements. For a particular 2-node bar element having nodes 4 and 5 located at distance '*l*', the displacements (along the bar axis) at its nodes are determined as u_4 = 5 mm, and u_5 = 8 mm. Determine the displacements at points located at distances '*l/4*', '*l/3*', and *'l/2'* measured from the node 4.

[5]

Q2. Consider a triangular element having nodal coordinates as (3,5), (7,7), and (5,9). If a point 'P' is located within element and the shape functions N_1 and N_3 calculated at 'P' are N_1 = 0.2 and N_3 = 0.5, determine the coordinates of point 'P'.

[5]

Q3. Drive the shape functions for a 6-node triangular element in terms of its Area-coordinates (L_1, L_2 and L_3)**.**

[10]

Q4. Differentiate between the following:

(a) Plane stress and Plane strain conditions
(b) Lagrange and Serendipity Elements
(c) $C^2, C^1, and\ C^0$ elements
(d) 'Compatible' and 'In-compatible' Plate bending Elements

[12]

Q5. Write a short note on

(a) Iso-parametric elements
(b) Axi-symmetric Elements

[8]

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CE F435: Introduction to FEM
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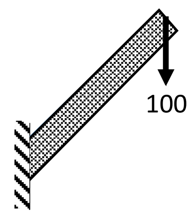
Part-B (Open Book)

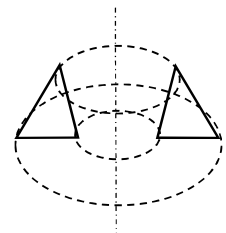
Duration: 105 Min. **Max. Marks: 60**

Q1. A one-meter-long member (area 1000 mm^2) is fixed at wall such that it makes an angle of 45^o from horizontal. The member is subjected to a vertically downward force of 100 N at free end. Discretizing the member in to single element, determine the displacements at free end and the reactions at wall. Neglect the axial deformation in the member and take $E = 2 \times 10^5\ N/mm^2$ and $\nu = 0.2$.



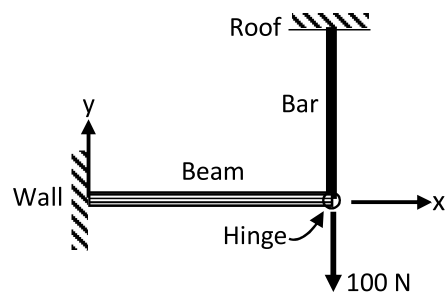
[15]

Q2. For a cylinder with tapered wall, the inner outer radius at the base is 200 mm and 400 mm respectively and at the top located at 400 mm from base, the radius is 300 mm. Along the thickness the cylinder is discretized in to single element as shown in Figure. The nodal coordinates of element are (in cm): (r_1= 20, z_1= 10), (r_2= 40, z_2 = 10), and (r_3 = 30, z_3 = 50). Determine the strain-displacement matrix for the element at the centroid of the element.



[15]

Q3. A beam and a bar members are pinned as shown in figure and the other ends of the beam and bar are rigidly connected to supports. A concentrated load is applied at the pinned joint. Neglecting the axial deformation in beam, determine the displacements at pinned joint.



[15]

Q4. A 4-node quadrilateral element has the nodes at (0,0), (2,0), (2,1) and (0,1) in Cartesian coordinate system. Using the one-point integration, determine the Strain-displacement matrix for the element. If the nodal displacements determined at the nodes (in cms) are $u_1 = 0.0, v_1 = 0.0$; $u_2 = 0.02, v_2 = 0.03,$; $u_3 = 0.06, v_3 = 0.015$; $u_4 = 0.1, v_4 = 0.0$, calculate the stresses at the centroid of element considering the plane stress condition. Take $E = 20 \times 10^6\ N/cm^2, and\ \nu = 0.25$.

[15]