BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: M.Tech. **SEMESTER : II**
BRANCH: Civil **SESSION : SP/22**

SUBJECT: Finite Element Method (CE506)

TIME: 2 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 10 questions each of 5 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**

Q.1 The plane truss shown in Figure 1 is composed of members having a cross sectional area of 0.2 m^2 and modulus of elasticity E = 75 GPa. Compute the element stiffness matrix of member 1 in the global co-ordinate system. [5]

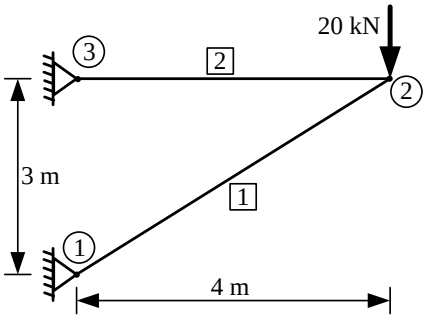


Figure 1

Q.2 Displacement field for three-nodded bar element (shown in Figure 2) is given by $u = N_1u_1 + N_2u_2 + N_3u_3$. Derive the shape functions (N_1, N_2, N_3) for the three-nodded bar element. [5]

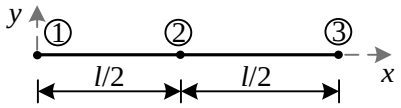


Figure 2

Q.3 Show that the displacement field given in the Q.2 includes the required capability to represent the rigid body deformation of bar. Use the shape functions derived in Q2. [5]

Q.4 Calculate the equivalent nodal load vector for the beam given in Figure 3. Interpolation functions for two-nodded beam element is given by **[5]**

$$N_1 = 1 - \frac{3x^2}{L^2} + \frac{2x^3}{L^3},\quad N_2 = x - \frac{2x^2}{L} + \frac{x^3}{L^2},\quad N_3 = \frac{3x^2}{L^2} - \frac{2x^3}{L^3},\quad N_4 = -\frac{x^2}{L} + \frac{x^3}{L^2}$$

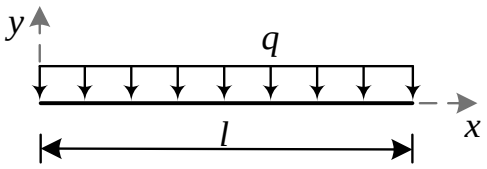


Figure 3

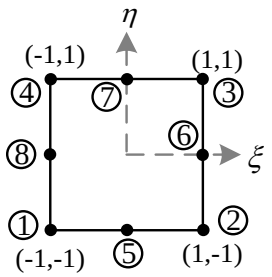
Q.5 Use Galerkin's method of weighted residuals to obtain an approximate solution of the differential equation [5]

$$\frac{d^2y}{dx^2} + y = 2x \quad 0 \le x \le 1$$

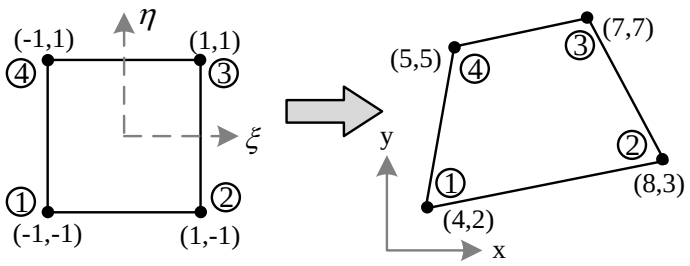
With boundary condition $y(0) = 0$, $y(1) = 0$.

P.T.O

Q.6 Derive the polynomial form of the shape functions numbered N_1 and N_5 for the following element [5]



Q.7 Derive the Jacobian matrix for the isoperimetric mapping of linear element (shown in the figure)



Q.8 Evaluate the following integral using 2-point Gauss quadrature: [5]

$$\int_{-1}^{1}\int_{-1}^{1}(1+2x+3x^2y)\,dx\,dy$$

Q.9 Explain the following steps in context of any commercial FE Application: [5]

a) Pre-Processing
b) Analysis
c) Post-processing

Q.10 Write short notes on plane stress and plane strain idealization. [5]

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29/04/2022