USN

10ME64

# Sixth Semester B.E. Degree Examination, Jan./Feb. 2023
## Finite Element Methods

Time: 3 hrs. Max. Marks:100

***Note: Answer any FIVE full questions, selecting at least TWO questions from each part.***



Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

### PART – A

1 a. What are the steps involved in FEM? **(05 Marks)**
b. Explain briefly different types of elements. **(05 Marks)**
c. Explain briefly plane stress and plain strain problems with examples. **(10 Marks)**

2 a. Obtain an element stiffness matrix by direct stiffness approach. **(10 Marks)**
b. Determine the nodal displacement for spring system shown in Fig.Q2(b).

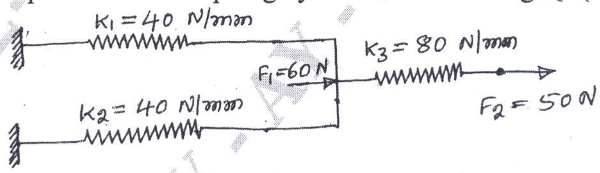


Fig.Q2(b) **(10 Marks)**

3 a. Explain convergence requirements in FEM. **(05 Marks)**
b. Explain 2D Pascal's triangle for triangular elements. **(05 Marks)**
c. Derive Jacobian matrix for CST element. **(10 Marks)**

4 a. Determine the nodal displacements for thin plate of uniform thickness of 1 mm as shown in the Fig.Q4(a). Take Young's modulus as 200 GPa, weight density of the plate is $76.6 \times 10^{-6}$ N/mm$^3$.

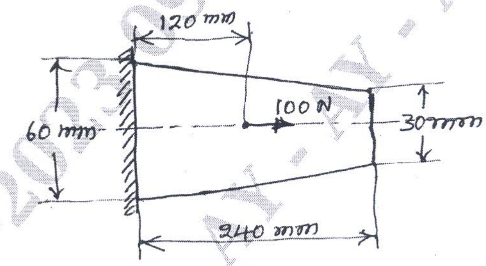


Fig.Q4(a) **(10 Marks)**

b. Solve the following system of simultaneous equations by Gaussian elimination method:

$$5x_1 + 4x_2 - 3x_3 = 2$$
$$6x_1 + 2x_2 + 3x_3 = 3$$
$$3x_1 - x_2 + 5x_3 = -6$$

**(10 Marks)**

### PART – B

5 a. Derive shape functions for linear quadri-lateral element using Lagrangian method. **(08 Marks)**
b. Explain briefly isoparametric, subparametric and superparametric elements. **(06 Marks)**
c. Evaluate the following integral using Gaussian quadrature $I = \int_{-1}^{+1} (1 + r + 2r^2 + 3r^2)dr$. **(06 Marks)**

6 a. Derive transformation matrix for truss element. (08 Marks)

b. Determine the global stiffness matrix for a truss system shown in the Fig.Q6(b). Take area of each truss element 1000 $mm^2$ and modulus of elasticity as 200 GPa.

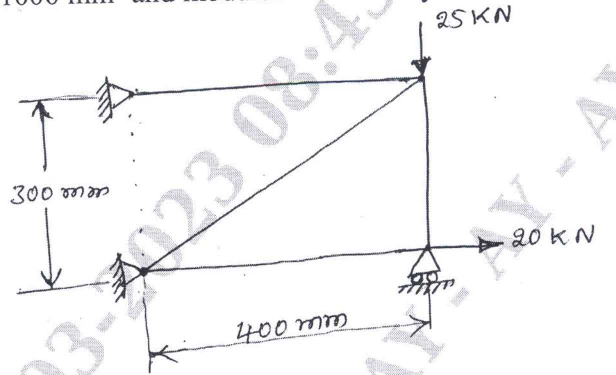


Fig.Q6(b) (12 Marks)

7 a. Derive stiffness matrix for a beam element. (12 Marks)

b. Determine the deflection and slope at the free end of the Cantilever beam subjected to a point load of 250 kN at free end. The length of the beam is 0.8 m. Take the moment of inertia as $4 \times 10^6$ $mm^4$ and Young's modulus as 200 GPa. (08 Marks)

8 a. Derive temperature gradient matrix for 1-D element. (10 Marks)

b. Determine the temperature distribution of the rectangular fin as shown in Fig.Q8(b) assuming conduction process and steady state. Take heat generated inside the fin as 400 $W/m^3$.

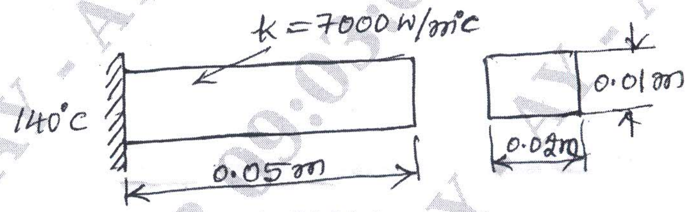


Fig.Q8(b) (10 Marks)

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