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Sixth Semester B.E. Degree Examination, Jan./Feb. 2021
Finite Element Methods

Time: 3 hrs.

Max. Marks:100

Note: 1. Answer any FIVE full questions, selecting at least TWO questions from each part.
 2. Missing data may be assumed suitably.

PART - A

1. a. Explain basic steps in Finite Element Method. (06 Marks)
 b. Explain equilibrium equations in elasticity subjected to body and traction forces. (06 Marks)
 c. Explain node numbering scheme and its effect on the half bandwidth. (08 Marks)

2. a. State the principle of minimum potential energy. Determine the displacements at nodes for the spring system shown in Fig Q2(a), Take : $K_1 = 50\text{N/mm}$; $K_2 = 60\text{N/mm}$; $K_3 = 70\text{N/mm}$
 $F_1 = 75\text{N}$; $F_2 = 100\text{N}$.

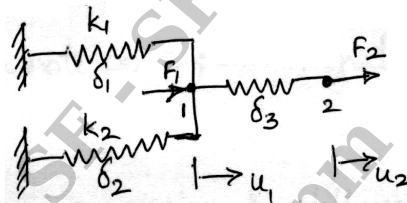


Fig Q2(a)

(08 Marks)

- b. Write the properties of stiffness matrix and derive the element stiffness matrix for a 1D bar element using direct stiffness method. (08 Marks)
 c. Write a note on Galerkin's method. (04 Marks)

3. a. Write a note on the polynomial involved in linear, quadratic and cubic 1D elements. (06 Marks)
 b. Derive shape functions for 2D Triangular element in Natural coordinate. (06 Marks)
 c. Derive shape functions for 2D Rectangular element in Natural coordinate. (08 Marks)

4. a. Fig Q4(a), show a bar subjected to a UDL of $P_0 = 100\text{N/m}$, Take $E = 70\text{GPa}$, Area (A) = 10^4mm^2 to determine : i) Nodal displacements ii) Stress in element.

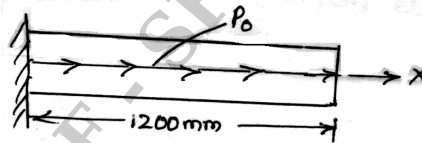


Fig Q4(a)

(08 Marks)

- b. Determine the nodal displacement, stress in each element and support reaction in the bar shown in Fig Q4(b) due to the applied force $P = 100\text{kN}$, Take $E_{\text{steel}} = 200\text{GPa}$, $E_{\text{copper}} = 100\text{GPa}$.

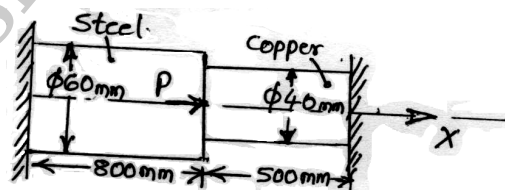


Fig Q4(b)

(12 Marks)

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 – B

- 5 a. Derive the shape function for a quadratic bar element using Lagrange’s interpolation. (06 Marks)
- b. With a sketch define ISO, sub and super parametric elements. (06 Marks)
- c. Write a note on 2-point integration rule for 1D and 2D problems. (08 Marks)

- 6 a. Obtain an expression for stiffness matrix of a truss element. (08 Marks)
- b. Determine the nodal displacement and stress in each element for the truss shown in Fig Q6(b), Take $E = 210\text{GPa}$, $A = 0.01\text{m}^2$.

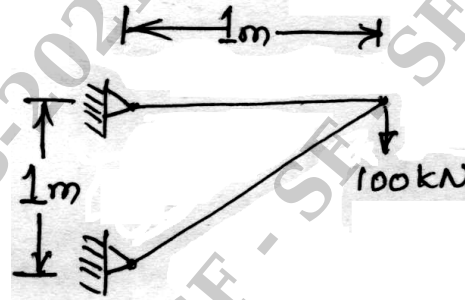


Fig Q6(b)

(12 Marks)

- 7 a. Define Hermite shape functions. Derive Hermite shape functions for the beam element. (10 Marks)
- b. Derive stiffness matrix for the beam element using Hermite shape functions. (10 Marks)

- 8 a. Derive conductivity matrix for a 1-D bar element with 2 nodes. (06 Marks)
- b. Compute the temperature distribution in the composite wall Fig Q8(b), using 1D heat elements. Use penalty approach of handling boundary conditions. Data: $K_1 = 20 \text{ W/m}^\circ\text{C}$; $K_2 = 30 \text{ W/m}^\circ\text{C}$; $K_3 = 50 \text{ W/m}^\circ\text{C}$; $T_\infty = 800^\circ\text{C}$; $h = 25 \text{ W/m}^2 \text{ }^\circ\text{C}$, $T_0 = 20^\circ\text{C}$.

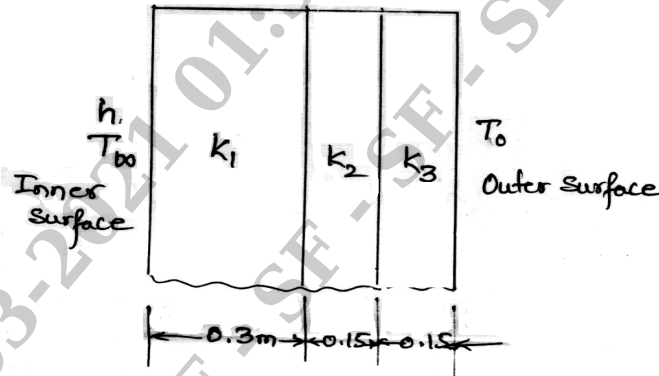


Fig Q8(b)

(14 Marks)
