USN | | | | | | | | | | **10ME64**

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.

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. 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 : $K_1 = 50N/mm$; $K_2 = 60N/mm$; $K_3 = 70N/mm$ $F_1 = 75N$; $F_2 = 100N$.

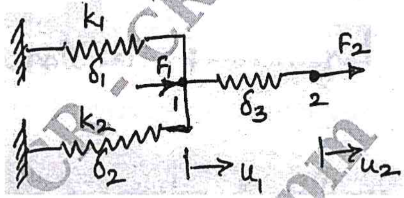

Fig Q2(a) **(08 Marks)**

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 10 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 = 100N/m, Take E = 70GPA, Area (A) = $10^4 mm^2$ to determine : i) Nodal displacements ii) Stress in element.

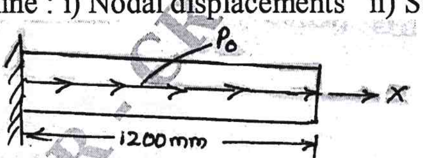

Fig Q4(a) **(08 Marks)**

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 = 100kN, Take E_{steel} = 200GPa, E_{copper} = 100GPa.

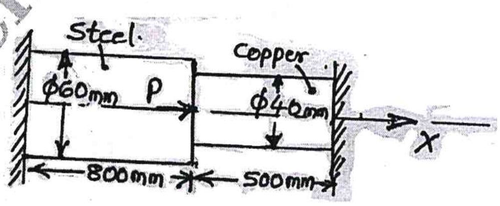

Fig Q4(b) **(12 Marks)**

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 = 210GPA, A = $0.01 m^2$.

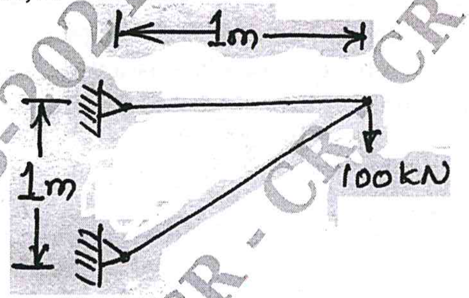

Fig Q6(b)

(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 W/m°C ; K_2 = 30 W/m°C ; K_3 = 50 W/m°C ; T_∞ = 800°C ; h = 25 W/m^2 °C, T_0 = 20°C.

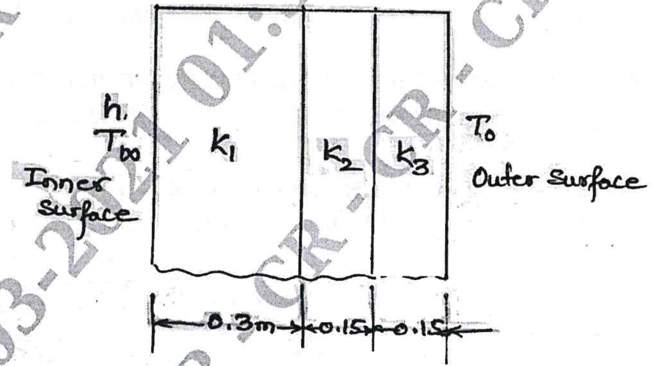

Fig Q8(b)

(14 Marks)

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