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**Sixth Semester B.E. Degree Examination, July/August 2021**  
**Finite Element Methods**

Time: 3 hrs.

Max. Marks:100

**Note: Answer any FIVE full questions.**

- 1 a. Explain the basic steps involved in finite element method for structural analysis. (06 Marks)
- b. Derive the stress-strain relations for both plane stress and plane strain conditions of a two-dimensional isotropic body. (10 Marks)
- c. Explain what is 'Half Bandwidth'. (04 Marks)
- 2 a. State the principle of minimum potential energy. (04 Marks)
- b. A Cantilever beam of span 'l' is subjected to a point load 'P' at the free end. The Young's modulus of elasticity of the beam material is 'E' and moment of inertia of section is 'I'. Using, second order polynomial, derive the equation for deflection by using Rayleigh-Ritz method. (10 Marks)
- c. Derive the element stiffness matrix for a two-noded one dimensional bar element using direct approach method. (06 Marks)
- 3 a. Derive the strain-displacement matrix [B] for a three-noded constant strain triangular (CST) element. (12 Marks)
- b. Explain the Pascal Triangle and write the general form of two-dimensional polynomial model. (08 Marks)
- 4 a. A bar is having uniform cross-sectional area of  $300 \text{ mm}^2$  and is subjected to a load  $P = 600 \text{ KN}$  as shown in Fig. Q4 (a).

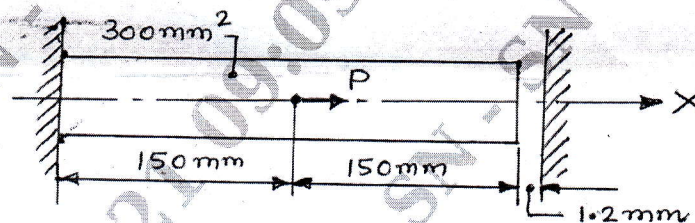


Fig. Q4 (a)

Determine the displacement field, stress and support reactions in the bar. Consider two-element model and use elimination method to handle boundary conditions.

Take  $E = 200 \text{ GPa}$ . (12 Marks)

- b. Solve the following system of equations for x, y and z using Gauss elimination method.
 
$$2x + y + z = 10$$

$$3x + 2y + 3z = 18$$

$$x + 4y + 9z = 16$$
 (08 Marks)

- 5 a. Using two-point Gaussian quadrature formula evaluate the following integral:
 
$$\int_{-1}^{+1} \int_{-1}^{+1} (r^2 + 2rs + s^2) dr ds.$$
 (10 Marks)
- b. Derive shape functions of two dimensional quadrilateral element of linear model using Lagrange's interpolation. (10 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.

- 6 a. Derive the element stiffness matrix for a two-dimensional plane truss element. (08 Marks)  
 b. Find the displacements at the nodes for the pin jointed plane truss shown in Fig. Q6 (b). Also find the stresses in the members of the truss. Assume  $E = 200 \text{ GPa}$ ;  $A_1 = 75\text{mm}^2$  and  $A_2 = 50\text{mm}^2$ . (12 Marks)

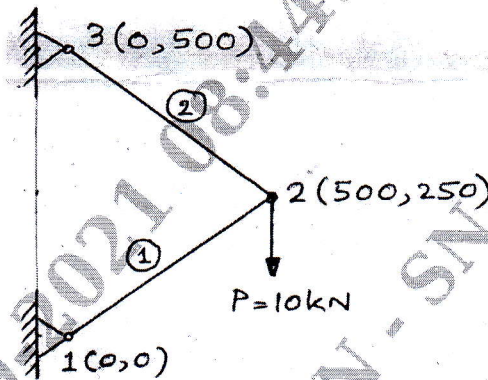


Fig. Q6 (b)

- 7 a. Derive the Hermite shape functions for a beam element and show their variation along the length of the element. (08 Marks)  
 b. For the beam loaded as shown in Fig. Q7 (b), determine the nodal deflection and slopes. Take  $E = 200 \text{ GPa}$  and  $I = 4 \times 10^6 \text{ mm}^4$ . (12 Marks)

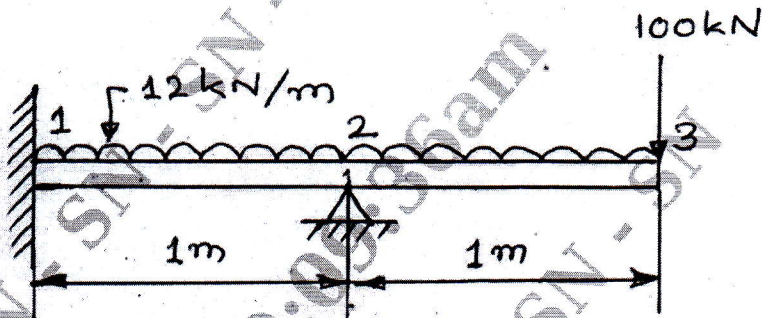


Fig. Q7 (b)

- 8 a. Derive element convection matrix for a one-dimensional uniform fin. (08 Marks)  
 b. A composite wall consists of two materials as shown in Fig. Q.No.8 (b). Determine the temperature distribution in the wall.

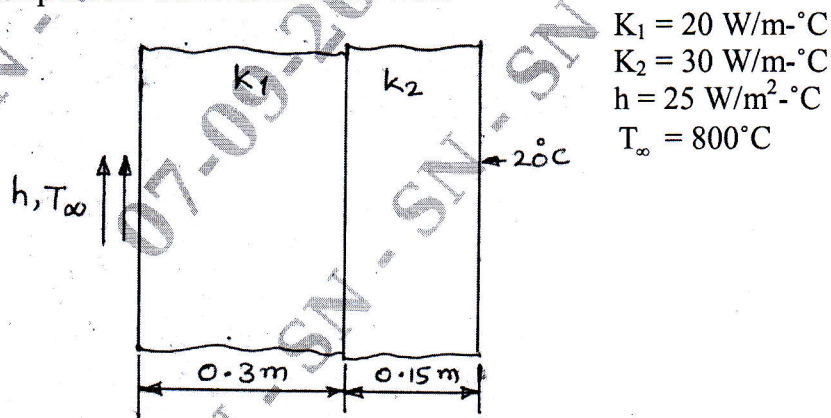


Fig. Q8 (b)

(12 Marks)