

CBCS SCHEME

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15AU73

Seventh Semester B.E. Degree Examination, July/August 2021

Finite Element Modeling & Analysis

Time: 3 hrs.

Max. Marks: 80

Note: Answer any FIVE full questions.

1. a. Differentiate between plane stress and plane strain problems with examples. Also write the stress-strain relations for both. (08 Marks)
 b. Solve the following system of simultaneous equations by Gauss elimination method,

$$2x_1 + x_2 - x_3 = 7$$

$$x_1 - 2x_2 + 3x_3 = 12$$

$$2x_1 + 4x_2 - 3x_3 = 10$$
(08 Marks)
2. a. Explain the principle of minimum potential energy. (04 Marks)
 b. Write the general steps involved in Rayleigh-Ritz method. (04 Marks)
 c. For the spring system shown in Fig. Q2 (c), using the principle of minimum potential energy, determine the nodal displacements. Take $F_1 = 75 \text{ N}$, $F_2 = 100 \text{ N}$. (08 Marks)

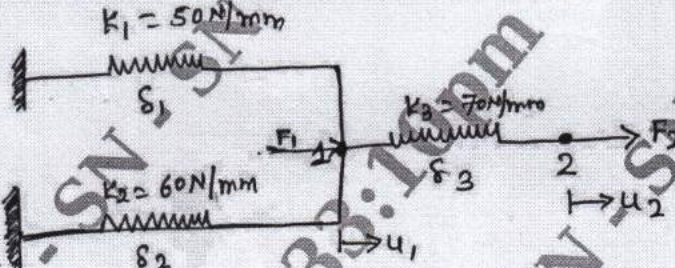


Fig. Q2 (c)

3. a. Explain the basic steps involved in FEM. (10 Marks)
 b. Discuss the applications and limitations of FEM. (06 Marks)
4. a. Derive the shape functions for quadratic bar element in natural coordinates. (08 Marks)
 b. Write the properties of shape functions. (03 Marks)
 c. Write briefly types of elements used in FEA. (05 Marks)
5. a. Determine the nodal displacements, stresses in each element and support reactions for the bar as shown in Fig. Q5 (a). Using elimination method for handling boundary conditions. (12 Marks)

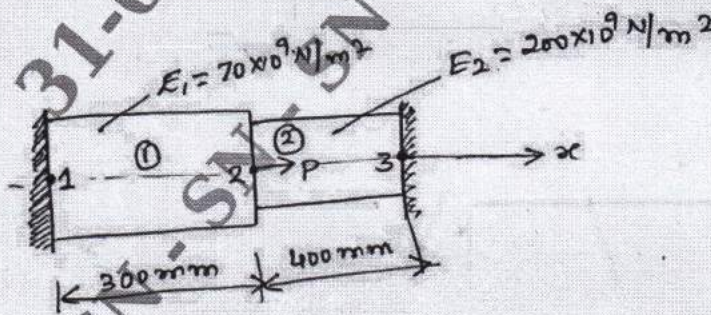


Fig. Q5 (a)

Take :
 $A_1 = 2400 \text{ mm}^2$
 $A_2 = 600 \text{ mm}^2$
 $P = 200 \times 10^3 \text{ N}$

- b. Write a short note on penalty method of handling boundary conditions. (04 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. For the two bar truss shown in Fig. Q6 (a), determine the nodal displacement, stresses in each element and support reactions. Take $E = 200 \text{ GPa}$, $A_1 = A_2 = 200 \text{ mm}^2$ (12 Marks)

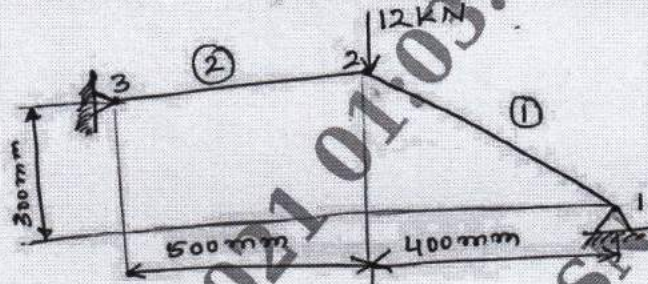


Fig. Q6 (a)

- b. Write the properties of stiffness matrix K . (04 Marks)
- 7 a. Derive the shape function for cubic bar element using Lagrangian polynomial. (08 Marks)
- b. Derive the shape function for 4-noded quadrilateral element using Lagrangian method. (08 Marks)
- 8 a. Explain the concept of isoparametric, sub parametric and superparametric elements. (06 Marks)
- b. Derive the shape function for nine-noded quadrilateral element. (10 Marks)
- 9 a. Derive the Hermite shape functions for beam element. (08 Marks)
- b. For the beam element shown in Fig. Q9 (b), determine the deflection under the given load. Take $E = 2 \times 10^9 \text{ kN/m}^2$ and $I = 4 \times 10^{-6} \text{ m}^4$. (08 Marks)

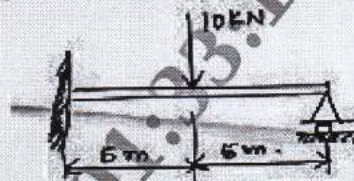
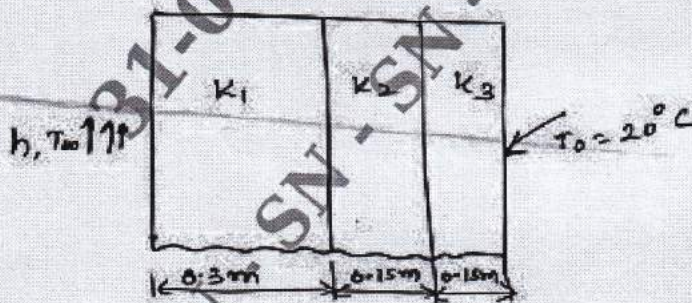


Fig. Q9 (b)

- 10 a. Discuss the Galerkin approach for 1-D heat conductor problem. (08 Marks)
- b. A composite wall consists of three materials as shown in Fig. Q10 (b). The outer temperature is $T_o = 20^\circ\text{C}$. Convection heat transfer takes place on the inner surface of the wall with $T_\infty = 800^\circ\text{C}$ and $h = 25 \text{ W/m}^2\text{C}$. Determine the temperature distribution in the wall. (08 Marks)



$K_1 = 20 \text{ W/m}^\circ\text{C}$
 $K_2 = 30 \text{ W/m}^\circ\text{C}$
 $K_3 = 50 \text{ W/m}^\circ\text{C}$

Fig. Q10 (b)
