CBCS SCHEME

USN

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 $F_1 = 75$ N, $F_2 = 100$ N. **(08 Marks)**

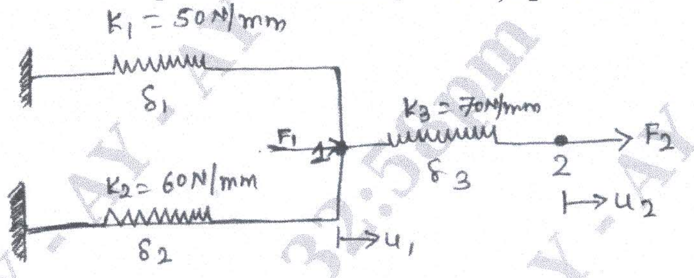


Fig. Q2 (c)

3 a. Explain the basic steps involved in FEM. **(10 Marks)**

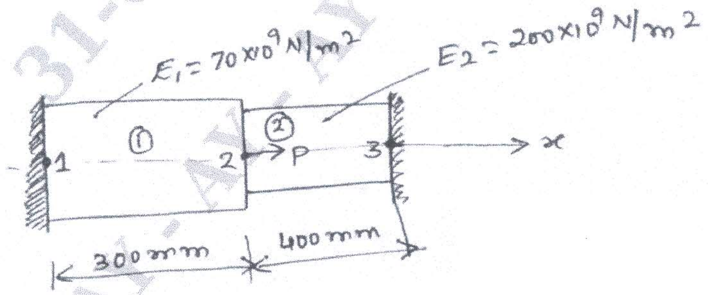
b. Discuss the applications and limitations of FEM. **(06 Marks)**

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)**



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

Fig. Q5 (a)

b. Write a short note on penalty method of handling boundary conditions. **(04 Marks)**

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 GPa, $A_1 = A_2 = 200\ mm^2$ **(12 Marks)**

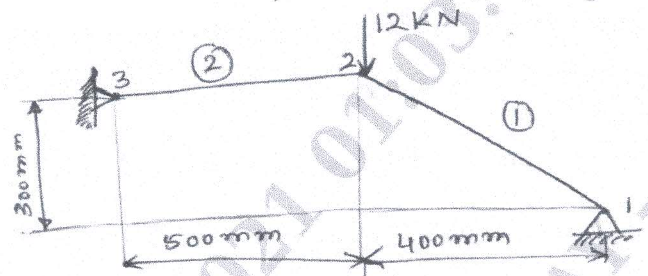


Fig. Q6 (a)

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 $E = 2\times10^9\ kN/m^2$ and $I = 4\times10^{-6}\ m^4$. **(08 Marks)**

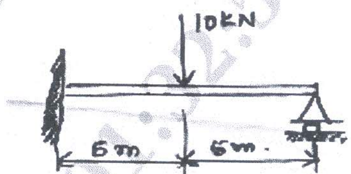
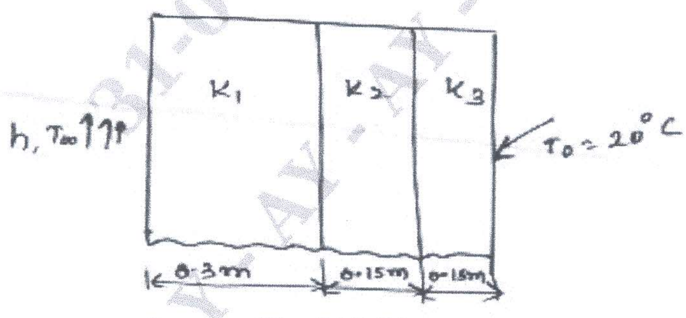


Fig. Q9 (b)

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 $T_o = 20^\circ C$. Convention heat transfer takes place on the inner surface of the wall with $T_\infty = 800^\circ C$ and $h = 25\ W/m^2\,^\circ C$. Determine the temperature distribution in the wall. **(08 Marks)**



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

Fig. Q10 (b)

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