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CBCS SCHEME

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18AU71

Seventh Semester B.E. Degree Examination, June/July 2024

Finite Element Modeling and Analysis

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

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.

Module-1

1 a. Derive the equilibrium equations for 3-D elastic body subjected to body force, surface and point load. **(10 Marks)**

b. Explain with a neat sketch, plane stress and plane strain conditions. **(10 Marks)**

OR

2 a. A rectangular bar of cross sectional area A, Elastic modulus E, when subjected to axial loading P. Prove that at a distance of 'x' from fixed end is $u = \left(\frac{P}{AE}\right)x$. **(10 Marks)**

b. Explain the principle of minimum potential energy. **(04 Marks)**

c. Solve the following system of equations by Gauss-elimination method.

$$x + y + z = 9$$
$$x - 2y + 3z = 8$$
$$2x + y - z = 3$$

(06 Marks)

Module-2

3 a. Derive the stiffness matrix for the bar element subjected to axial load 'F' using direct method. **(10 Marks)**

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

OR

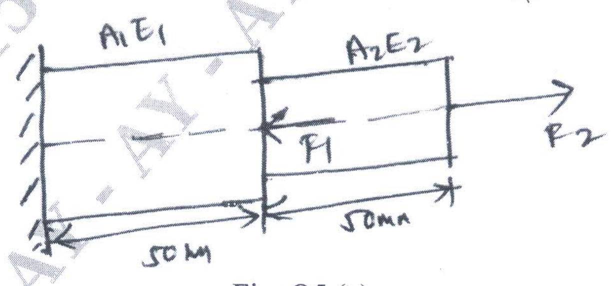
4 a. What is shape function? Derive the shape function for 1-D bar element in global co-ordinates. **(10 Marks)**

b. Explain the convergence requirements. **(04 Marks)**

c. List the applications and limitations of FEM. **(06 Marks)**

Module-3

5 a. Determine the nodal displacements and stress in each element for the stepped bar as shown in Fig. Q5 (a). **(10 Marks)**



$E_1 = 200$ GPa,
$E_2 = 70$ GPa,
$A_1 = 150\ mm^2$,
$A_2 = 100\ mm^2$
$F_1 = 10$ kN,
$F_2 = 5$ kN

Fig. Q5 (a)

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b. Using penalty approach for handling boundary condition. Determine the nodal displacements for 1-D bar as shown in Fig.Q5 (b). **(10 Marks)**

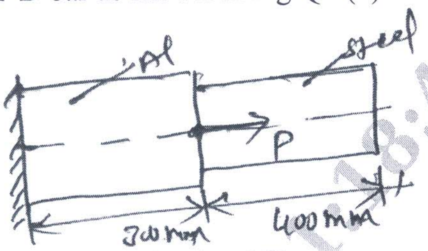


Fig. Q5 (b)

$P = 200\times10^3$ N,
$A_1 = 2400$ mm^2,
$E_1 = 70\times10^9$ N/m^2,
$A_2 = 600$ mm^2,
$E_2 = 200\times10^9$ N/m^2,
$\ell_1 = 300$ mm,
$\ell_2 = 400$ mm

OR

6 a. Derive the element stiffness matrix for truss element. **(10 Marks)**

b. A plane truss shown in Fig. Q6 (b), determine nodal displacement. **(10 Marks)**

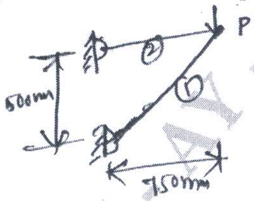


Fig. Q6 (b)

Module-4

7 a. Derive the shape function for linear bar element using Lagrangian interpolation. **(12 Marks)**

b. Brief about the properties of shape function. **(08 Marks)**

OR

8 a. Derive the hermite shape function for beam element. **(16 Marks)**

b. Draw the variation of shape function for 1-D cubic bar element. **(04 Marks)**

Module-5

9 a. Derive stiffness matrix for beam element. **(10 Marks)**

b. For the beam shown in Fig.Q9 (b), determine the load vector due to the load acting on the beam. **(10 Marks)**

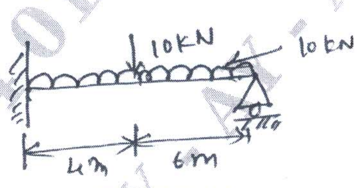
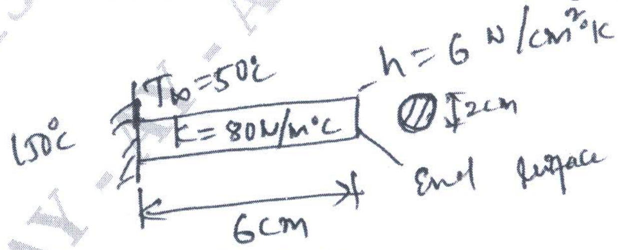


Fig. Q9 (b)

OR

10 a. Derive an expression for stiffness matrix for 3-D heat conduction. **(10 Marks)**

b. Find the temperature distribution for 1-D fin as shown in Fig. Q10 (b). **(10 Marks)**



$T_\infty = 50^\circ$C
$h = 6$ W/cm^2 $^\circ$K
$K = 80$ W/m $^\circ$C

Fig. Q10 (b)

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