USN

18AE/AS63

Sixth Semester B.E. Degree Examination, June/July 2023

Finite Element Method

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Explain plane stress and plane strain problems. **(06 Marks)**

b. List the type of elements with neat sketch. **(04 Marks)**

c. For the spring shown in Fig. Q1 (c), determine the nodal displacements using principle of minimum potential energy.

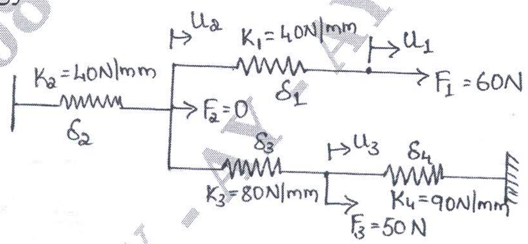

Fig. Q1 (c) **(10 Marks)**

OR

2 a. Explain the consideration to be taken in the discretisation process. **(10 Marks)**

b. Use the Rayleigh-Ritz method to find the displacement at the mid point of the rod shown in Fig. Q2 (b).

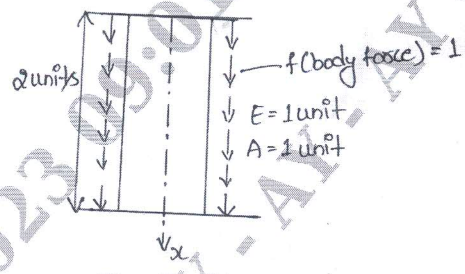

Fig. Q2 (b) **(10 Marks)**

Module-2

3 a. Derive shape function for 1-D bar element in global co-ordinate system. **(10 Marks)**

b. Consider the four bar truss shown in Fig. Q3 (b). It is given that $E = 2\times10^5$ N/mm^2 and A_e = 100 mm^2 for all elements. Determine the nodal displacement and stress in each element.

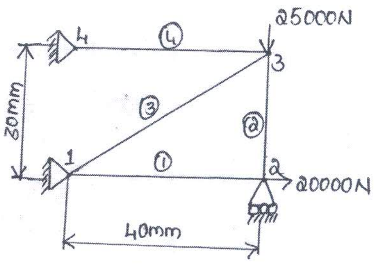

Fig. Q3 (b) **(10 Marks)**

OR

4 a. Derive the Hermite shape function for a beam element. **(10 Marks)**

b. Consider the bar shown in Fig.Q4 (b). An axial load $P = 200 \times 10^3$ N is applied as shown using penalty approach for handling boundary condition. Determine nodal displacement and stress in each element.

Take $A_1 = 2400\ mm^2$, $E_1 = 70 \times 10^9\ N/m^2$, $A_2 = 600\ mm^2$, $E_2 = 200 \times 10^9\ N/m^2$

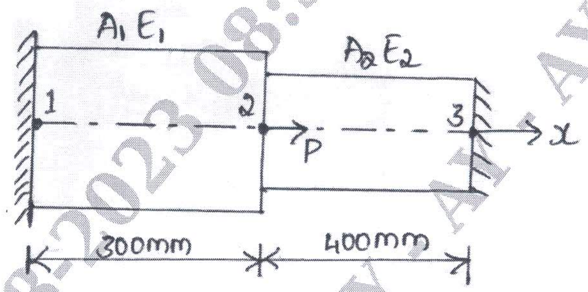

Fig. Q4 (b) **(10 Marks)**

Module-3

5 a. Derive Shape function for constant strain triangular element in global co-ordinate system. **(10 Marks)**

b. Derive shape function for a hexahedral element. **(10 Marks)**

OR

6 a. Derive shape function for Nine Node Rectangular element using Lagrange method. **(10 Marks)**

b. With usual notations, obtain the shape function for tetrahedral element. **(10 Marks)**

Module-4

7 a. Explain the structure of computer program for FEM analysis. **(10 Marks)**

b. Explain different phases in FEM. **(10 Marks)**

OR

8 a. Derive shape function for a Axisymmetric triangular element. **(10 Marks)**

b. Explain subparametric, ISO parametric and super parametric elements. **(10 Marks)**

Module-5

9 a. Derive expression for mass matrix for bar element. **(08 Marks)**

b. Find the distribution in the 1D fin shown in Fig. Q9 (b). Take two elements for FE idealization.

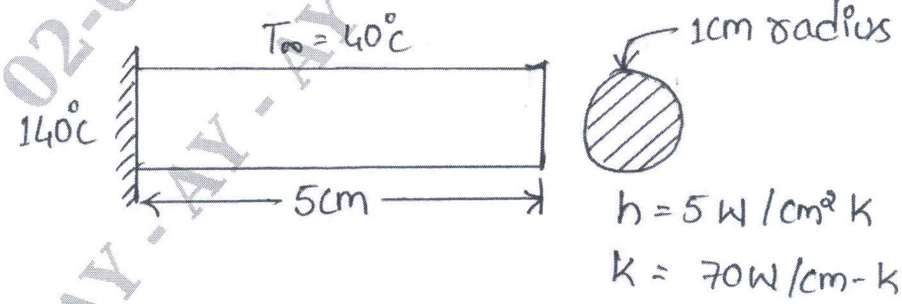

Fig. Q9 (b)

(12 Marks)

OR

10 a. Drive a differential equation for an 1-D heat conduction. **(04 Marks)**

b. Solve for temperature distribution in the composite wall as shown in Fig. Q10 (b), using 1-D heat elements, use penalty approach of handling boundary condition.

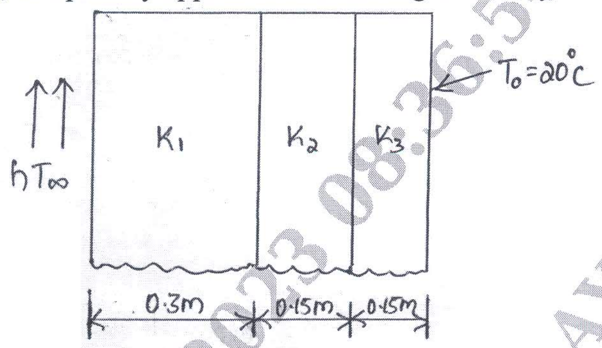

Fig. Q10 (b)

$K_1 = 20\ W/m^\circ C$
$K_2 = 30\ W/m^\circ C$
$K_3 = 50\ W/m^\circ C$
$T_\infty = 800^\circ C$
$h = 25\ W/m^2C$

(16 Marks)

* * * * *