CBCS SCHEME

USN | | | | | | | | | | |

18AU71

Seventh Semester B.E. Degree Examination, Feb./Mar.2022
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 an differential equation of equilibrium for a two dimensional body. **(08 Marks)**

b. Solve the following of simultaneous system equation by Gaussian elimination method:

$$x_1 - 2x_2 + 6x_3 = 0$$
$$2x_1 + 2x_2 + 3x_3 = 3$$
$$-x_1 + 3x_2 = 0$$
(08 Marks)

c. List the advantages and applications of FEM. **(04 Marks)**

OR

2 a. For the spring system shown in Fig. Q2 (a), using the principle of minimum potential energy. Determine the nodal displacements. Take : $F_1 = 75$ N and $F_2 = 100$ N **(10 Marks)**

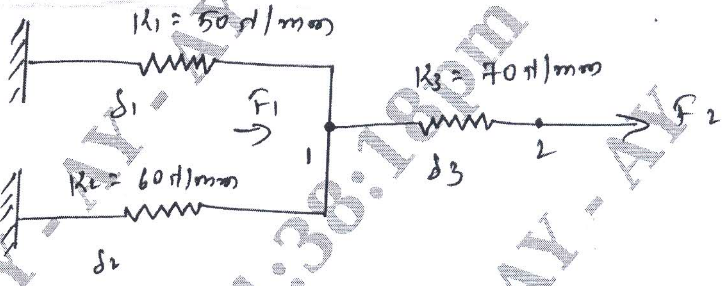


Fig. Q2 (a)

b. By R – R method, for a bar of cross sectional area of elastic modulus E, subjected to a uniaxial loading P. Show that at a distance x from fixed end is $u = \left(\frac{P}{AE}\right)x$ and hence determine the end deflection and the stress to which the bar is subjected to. **(10 Marks)**

Module-2

3 a. Explain the basic steps involved in FEM. **(08 Marks)**

b. Explain convergence requirements of a displacement field. **(04 Marks)**

c. Use Galerkin method, to find the displacement of the system shown in Fig. Q3 (c). **(08 Marks)**

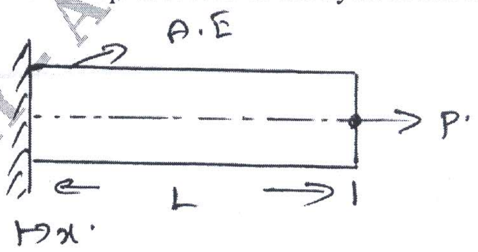


Fig. Q3 (c)

OR

4 a. Derive the shape function of a bar element in Global co-ordinate system. **(10 Marks)**

b. What is the purpose of Pascal's (2D Pascal's) triangle? **(05 Marks)**

c. Write a note on simplex, complex and multiplex element. **(05 Marks)**

Module-3

5 a. A bar is having uniform cross sectional area of 300 mm^2 and is subjected to a load P = 600 KN as shown in Fig. Q5 (a). Determine the displacement field, stress and support reaction in the bar. Consider two element and use elimination method to handle boundary conditions. Take E = 200 GPa. **(10 Marks)**

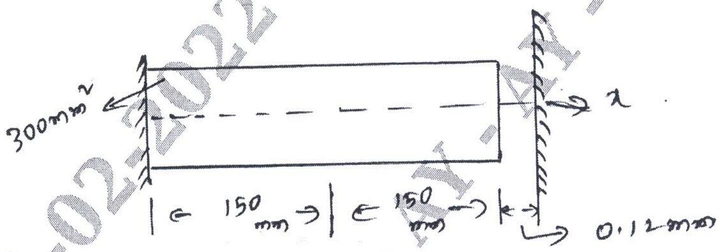


Fig. Q5 (a)

b. Determine the nodal displacement, stress in each element at the fixed support for the thin plate of uniform thickness of 1 mm of shown in Fig. Q5 (b). Take Young's modulus E = 200 GPa, Weight density of the plate P = 76.6×10^{-6} N/mm^3. In addition to its weight, it is subjected to a point load of 100 N at its mid point. Model the plate with two bar elements. **(10 Marks)**

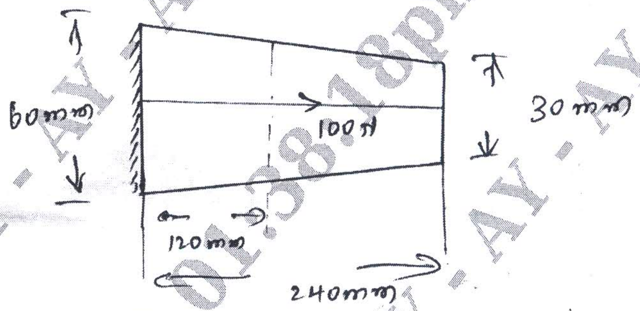


Fig. Q5 (b)

OR

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

b. For the two bar truss shown in Fig. Q6 (b). Determine the nodal displacement and the stress in each member. Also find the support reaction. Take E = 200 GPa.

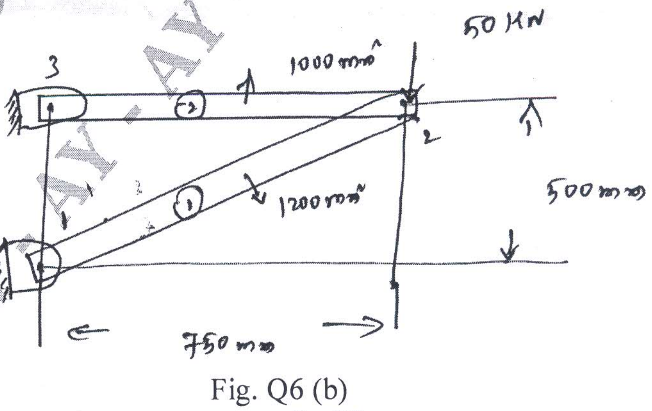


Fig. Q6 (b) **(10 Marks)**

Module-4

7 a. Derive shape function for 2-D elements quadrilateral/rectangular element. **(08 Marks)**

b. Explain the following with neat sketch:
   (i) Iso-parameteric element.
   (ii) Sub-parametric element.
   (iii) Super-parametric element. **(06 Marks)**

c. Compute the value of integral $\int_{-1}^{+1}\left(3e^{\xi}+\xi^{2}+\frac{1}{\xi+2}\right)d\xi$ using one point and two point Gaussian quadrature. **(06 Marks)**

OR

8 a. Derive element stiffness matrix for beam element using shape function. **(10 Marks)**

b. Fig. Q8 (b) shows a simply supported beam subjected to a uniformly distributed load. Obtain the maximum deflection. Take Young's modulus E = 200 GPa and moment of inertia $I = 2\times10^{6}\ \text{mm}^{4}$.

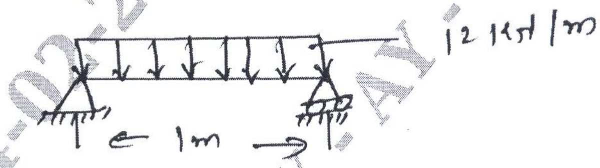
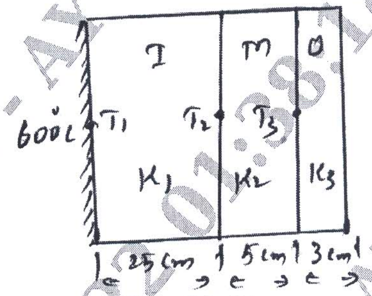


Fig. Q8 (b) **(10 Marks)**

Module-5

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

b. An induction furnace wall is made up of three layers, inside, middle and outer layer with thermal conductivity K_1, K_2 and K_3 respectively shown in Fig. Q9 (b). Determine nodal temperature. **(10 Marks)**



$K_1 = 8.5$ W/mk
$K_2 = 0.25$ W/mk
$K_3 = 0.08$ W/mk
$h = 45$ W/m^{2}k
$T_\infty = 30^\circ$C

Fig. Q9 (b)

OR

10 a. Derive equation for heat transfer through thin fin's. **(10 Marks)**

b. Determine the temperature distribution in a one dimensional fin shown in fig.Q10 (b). There is a generation uniform heat inside the wall of 500 W/m^3.

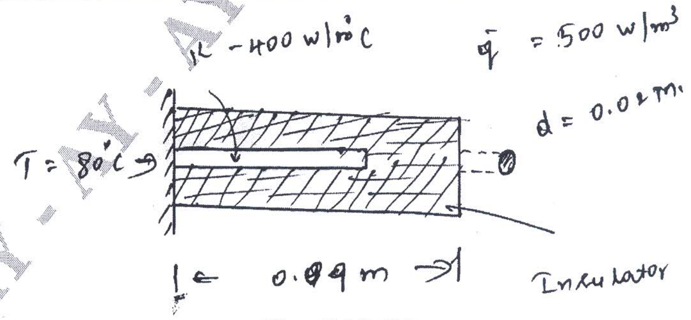


Fig. Q10 (b) **(10 Marks)**

* * * * *