USN | | | | | | | | | | | | **18AU71**

Seventh Semester B.E. Degree Examination, Jan./Feb. 2023
Finite Element Modeling and Analysis

Time: 3 hrs.   Max. Marks: 100

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

Module-1

1   a.   Derive the equilibrium equation for 3D elastic body.   **(10 Marks)**
    b.   For the spring system shown in Fig Q1(b). Using principle of minimum potential energy, determine the Nodal displacement take $F_1 = 70N$ and $F_2 = 105N$

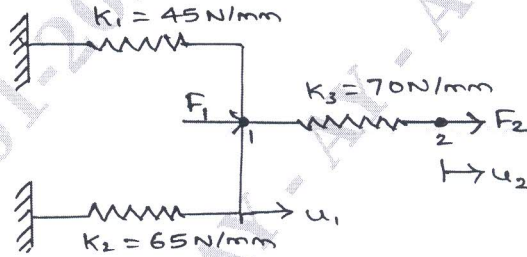Fig Q1(b)   **(10 Marks)**

OR

2   a.   With neat sketch, explain plane stress and plain strain. Also state the assumptions. **(10 Marks)**
    b.   A bar of length L, cross sectional Area A and modulus of elasticity E, is subjected to distributed axial load q = cx, where C is a constant as shown in Fig Q2(b). Determine the displacement of the bar at the end using Rayleigh – Ritz method.

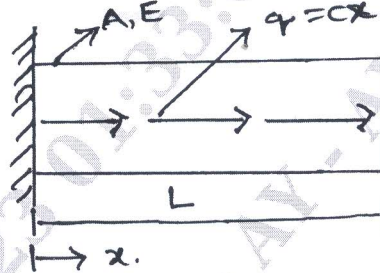Fig Q2(b)   **(10 Marks)**

Module-2

3   a.   Use the Galerkin's method to obtain the approximate solution of the differential equation $\dfrac{d^2y}{dx^2} - 10x^2 = 5$ $0 \le x \le 1$. With boundary condition $y(0) = y(1) = 0$. Take the trail functions as $N_1(x) = x(x - 1)$ and $N_2(x) = x^2(x - 1)$. **(10 Marks)**
    b.   Explain basic steps involved in FEM.   **(10 Marks)**

OR

4   a.   Explain the stiffness matrix. Derive the stiffness matrix for the Bar element.   **(10 Marks)**
    b.   Derive the shape functions for Linear bar element in natural coordinates. (ID)   **(10 Marks)**

Module-3

5 a. Determine the Nodal displacement vector for the bar shown in Fig Q5(a), using penalty approach of handling boundary conditions.

$$P = 4000N$$
$$A_1 = 1600mm^2$$
$$A_2 = 800mm^2$$
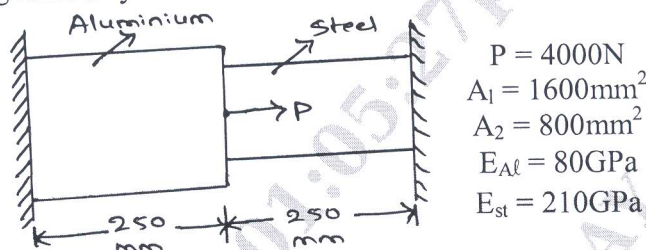$$E_{Al} = 80GPa$$
$$E_{st} = 210GPa$$

Fig Q5(a) **(10 Marks)**

b. Solve the following system of simultaneous equation by Gaussian elimination method.
$$x_1 - 2x_2 + 6x_3 = 0$$
$$2x_1 + 2x_2 + 3x_3 = 3$$
$$- x_1 + 3x_2 = 2$$

(10 Marks)

OR

6 a. Define Truss. State assumptions mode in analysis of trusses. **(04 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 = 200GPA.

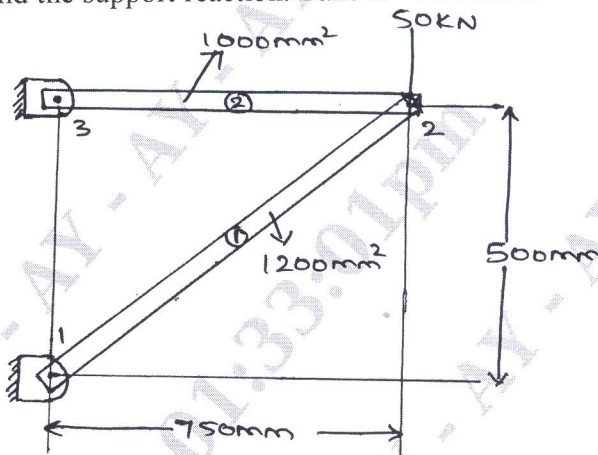Fig Q6(b) **(16 Marks)**

Module-4

7 a. With line diagram, explain isoparametric sub and superparameteric elements. **(10 Marks)**

b. Derive the shape functions for a three noded quadratic bar element. **(10 Marks)**

OR

8 a. Derive the shape function for two noded bar element (one dimensional) using Langrangian polynomial. **(10 Marks)**

b. Write a short note on : **(10 Marks)**
   i) Properties of shape functions
   ii) Langrange interpolation function

Module-5

9 a. Fig Q9(a) shown a simply supported beam subjected to a uniformly distributed load, obtain the maximum deflection. Take $E = 200$GPa and $I = 2 \times 10^6 mm^4$.
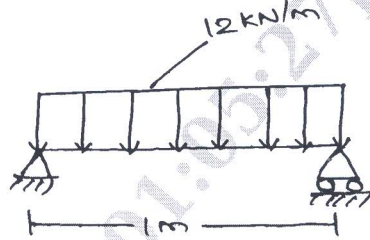

Fig Q9(a) **(10 Marks)**

   b. A uniform cross sectional beam is fixed at one end supported by a roller at the other end. A concentrated 20kN is applied at the mid length of the beam as shown in Fig Q9(b). Determine the deflection under load. Take $E = 210$GPa and $I = 2500$ mm^4.
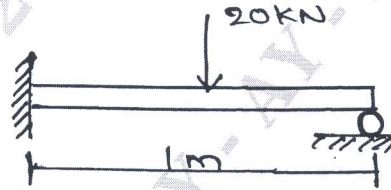

Fig Q9(b) **(10 Marks)**

OR

10 a. Obtain differential equation for 1D Heat conduction. **(06 Marks)**
    b. Explain Heat transfer in thin fins. **(04 Marks)**
    c. Solve for temperature distribution in the composite wall as shown in Fig Q10(c), using 1-D heat elements, use penalty approach of handling boundary condition.
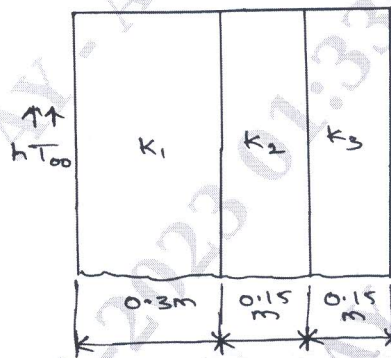

$K_1 = 20$W/m°C
$K_2 = 30$ W/m°C
$K_3 = 50$ W/m°C
$T_\infty = 800$°C
$h = 25$W/m^{2}C

Fig Q10(c)

(10 Marks)

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