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18AU71

Seventh Semester B.E. Degree Examination, July/August 2022  
**Finite Element Modelling 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. Write the basic steps in finite elements method. (10 Marks)  
b. Derive the differential equation of equilibrium for a 2D body. (10 Marks)

OR

- 2 a. Write the advantages, disadvantages and applications of finite element method. (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.

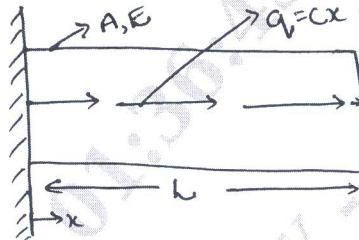


Fig.Q2(b)

(10 Marks)

**Module-2**

- 3 a. Define shape functions. And derive the shape function in Global co-ordinate (or) Cartesian co-ordinates. (10 Marks)  
b. Explain Pascal triangle by geometric invariance. (06 Marks)  
c. Write the convergence requirements. (04 Marks)

OR

- 4 a. Derive the shape function in natural co-ordinates. (10 Marks)  
b. Use the Galerkin's method, to obtain the approximate solution of the differential equation

$$\frac{d^2y}{dx^2} - 10x^2 = 5, \quad 0 \leq x \leq 1$$

with boundary condition  $y(0) = y(1) = 0$  Take the trial functions as  $N_1(x) = x(x - 1)$  and  $N_2(x) = x^2(x - 1)$ . (10 Marks)

Module-3

- 5 a. Using Penalty method of handling boundary condition determine the nodal displacement, stress in each element and support reaction in the bar shown in Fig.Q5(a) due to applied force  $P = 100\text{kN}$  take  $E_{\text{steel}} = 200\text{GPa}$   $E_{\text{cu}} = 100\text{GPa}$ .

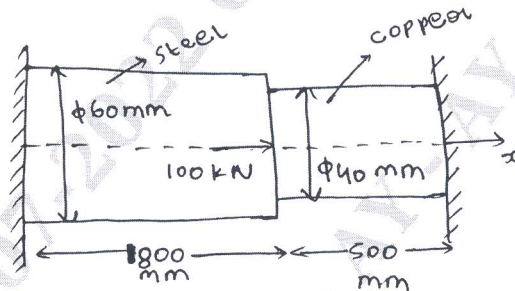


Fig.Q5(a)

(10 Marks)

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

$$\begin{aligned}x_1 &= 2x_2 + 6x_3 = 0 \\2x_1 + 2x_2 + 3x_3 &= 3 \\-x_1 + 3x_2 &= 2.\end{aligned}$$

(10 Marks)

OR

- 6 Consider the Four-bar truss shown in Fig.Q6 it is given that  $E = 2 \times 10^5 \text{ N/mm}^2$  and  $A_s = 100\text{mm}^2$  for all elements.
- Determine the element stiffness matrix for each element
  - Assemble the elemental stiffness matrix 'k' for the entire truss
  - Using the elimination approach, solve for the nodal displacement
  - Calculate stresses in each element
  - Calculate the reaction forces.

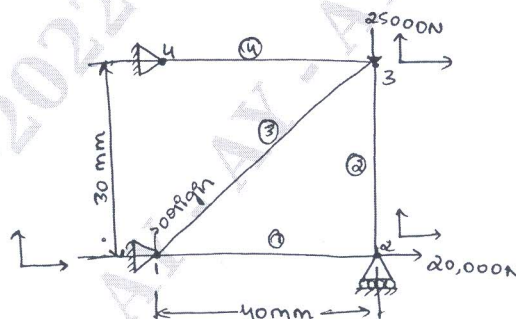


Fig.Q6

(20 Marks)

Module-4

- 7 a. Derive the shape function for a 4-noded quadratic bar element using lagrangian method. (10 Marks)
- b. Briefly explain sub parametric elements and super parametric elements. (06 Marks)
- c. Write the properties of shape functions. (04 Marks)

OR

- 8 a. Using Gaussian quadratic formula, evaluate :

$$I = \int_{-1}^{+1} (1 + r + 2r^2 + 3r^3) dr$$

(08 Marks)

- b. Evaluate the value of the integral  $I = \int_2^4 X dx$ .

(08 Marks)

- c. What are higher order and isoparametric elements?

(04 Marks)

**Module-5**

- 9 a. Using Hermite shape function, derive the element stiffness matrix. (10 Marks)  
 b. Determine the deflection at the centre of the position of the beam carrying UDL.

$$E = 200 \text{ GPa ;}$$

$$I = 4 \times 10^6 \text{ mm}^4.$$

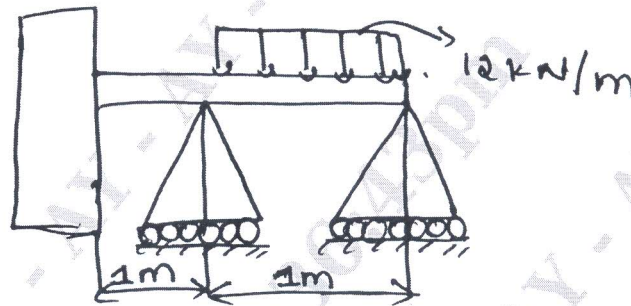


Fig.Q9(b)

(10 Marks)

OR

- 10 a. Derive the equation for shape function of 1-D heat conduction. (10 Marks)  
 b. For the beam element shown in Fig.Q10(b), determine deflection under the given load.

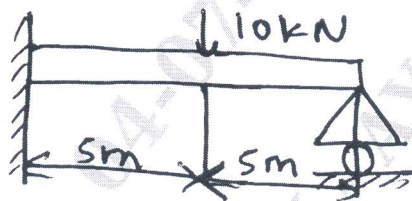


Fig.Q10(b)

$$E = 2 \times 10^8 \text{ kN/m}^2.$$

$$I = 4 \times 10^{-6} \text{ m}^4.$$

(10 Marks)

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