

## FINITE ELEMENT ANALYSIS

Q. P. Code: 24911

(3 Hours)

Max. Marks: 80

Note:

1. Question 1 is Compulsory
2. Solve any three from remaining five
3. Figures to right indicate full marks
4. Assume suitable data if necessary

Question

Max.

No.

Marks

- Q.1
- a) Write short note on Advantages and limitations of Finite Element Method 20
  - b) Derive shape function for 1D quadratic element in natural co-ordinates.
  - c) Explain plane stress and plane strain conditions with figure.
  - d) Elaborate convergence with example.

- Q.2
- a) The governing differential equation for the steady state one dimensional conduction heat transfer with internal heat generation is given by 10

$$\frac{d}{dx} \left[ k \frac{dT}{dx} \right] = q \text{ for } 0 \leq x \leq L$$

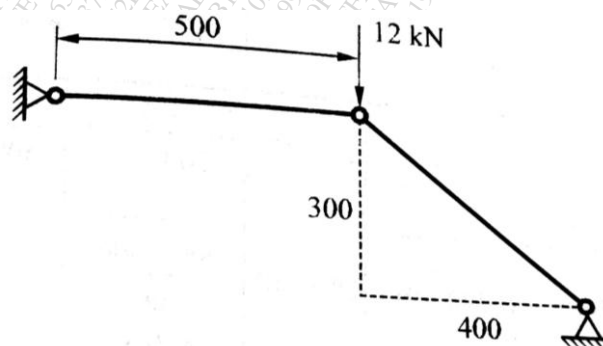
where

k= coefficient of thermal conductivity of the material,

q= internal heat generation

Develop the finite element formulation for linear element. Use Rayleigh Ritz method, mapped over general element.

- b) For the two bar truss as shown in fig, determine the nodal displacements and stress in each member. Take  $E = 70 \text{ GPa}$  and area for both members  $= 200 \text{ mm}^2$ . 10



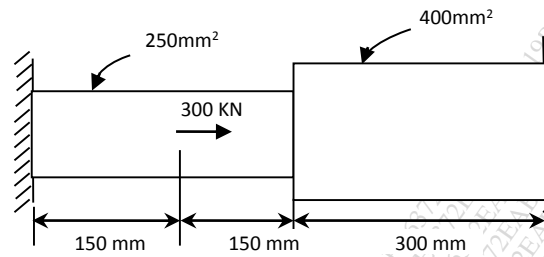
- Q.3
- a) Solve following differential equation by Galerkin method. 10

$$\frac{d^2 u}{dx^2} + u = x^2, 0 \leq x \leq 1$$

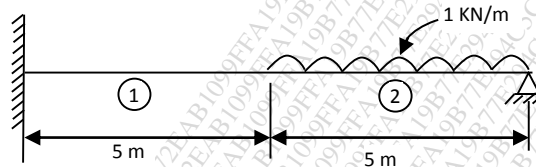
Given Boundary Conditions are:  $u = 0$  at  $x = 0$ ,  $\frac{du}{dx} = 1$  at  $x = 1$

Find values for  $u(0.3)$  &  $u(0.6)$

- b) Find the displacement, stresses and strain in the elements of stepped bar as shown in figure. Take  $E = 200 \text{ GPa}$ . 10

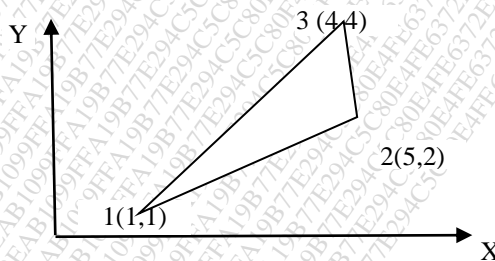


- Q.4 a) Find the deflection and slopes at nodes and reactions at supports for the beam as shown in figure. Take  $E = 200 \text{ GPa}$ ,  $I_1 = 2 \times 10^7 \text{ mm}^4$  and  $I_2 = 1 \times 10^7 \text{ mm}^4$ . 12



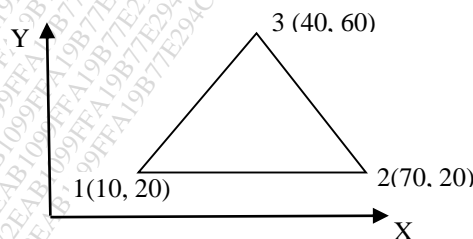
- a) Derive shape function in natural coordinate system for eight noded quadrilateral element. 08

- Q.5 a) A linear interpolation functions for a triangular element as shown in figure. 10



- b) Find the two natural frequencies of transverse vibrations of a beam fixed at both ends. Use Lumped mass matrix. Assume length of beam as 1 unit,  $EI = 10^6$  units,  $\rho A = 10^6$  units. 10

- Q.6 a) Evaluate the stiffness matrix for the CST element shown below. 10  
Coordinates are given in mm. Assume plane stress condition.  
Thickness = 10mm,  $E = 200 \text{ GPa}$  and  $\gamma = 0.3$ .



- b) Explain significance of Jacobian matrix. Derive for CST element. 10

\*\*\*\*\*