

Total Marks: 80

(3 Hours)

N.B.:

- 1) Question No. 1 is compulsory.
- 2) Attempt any three questions out of remaining five questions.
- 3) Assume suitable data if required.

[Each 5 Marks]

Q1 Solve any 4

- i) Explain with neat sketch the Finite Element methods.
- ii) What is Boundary Condition? Explain its type in brief?
- iii) Derive the shape function for One Dimensional Linear Element in Natural Coordinates.
- iv) What are the sources of Errors in FEA?
- v) Explain in brief Jacobian Matrix in FEA.
- vi) Write in brief about Consistent and Lumped mass matrix.

Q2 a) Solve the following differential equation using Galerkin Method.

[12]

$$\frac{d^2u}{dx^2} + 5 = 0; \quad \text{For } 0 < x < 1$$

Boundary Conditions are $x = 0$ and $u = 0$ and at $x = 1$; $\frac{du}{dx} + u = 0$

Find $u(0.2) = ?$

b) What is Convergence in FEA? Explain its types in brief.

[04]

c) Explain the Principle of minimum total potential with suitable example.

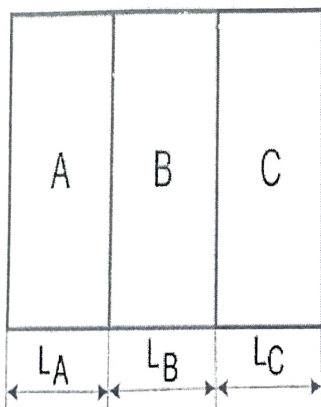
[04]

Q3 a) Find the temperature at interfaces and heat transfer per unit area through the wall.

[10]

$$T_L = 110^\circ\text{C},$$

$$h_L = 155 \text{ W/m}^2\text{C},$$



$$T_R = 35^\circ\text{C},$$

$$h_R = 25 \text{ W/m}^2\text{C},$$

$$L_A = 50\text{mm}$$

$$L_B = 50\text{mm},$$

$$L_C = 50\text{mm}$$

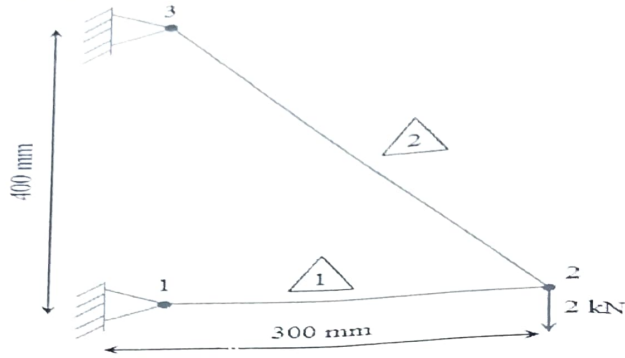
$$K_A = K_B = K_C = 45 \text{ W/m}^2\text{C}$$

Where K - denotes thermal conductivity, h - denotes heat transfer coefficient and T -temperature.
Where f is the weight of the bar. Consider one end of the bar to be fixed and other end free.

b) Develop the finite element equation for the most general element using Rayleigh Ritz Method for vertical bar with axial loading. The governing differential equation is given below [10]

$$\frac{d}{dx} \left(EA \frac{du}{dx} \right) + f = 0 \quad ; 0 \leq x \leq L$$

Q4 a) Analyze the truss for displacement Shown in fig
Take $E = 200 \text{ GPa}$ and $\text{Area} = 100 \text{ mm}^2$ [12]

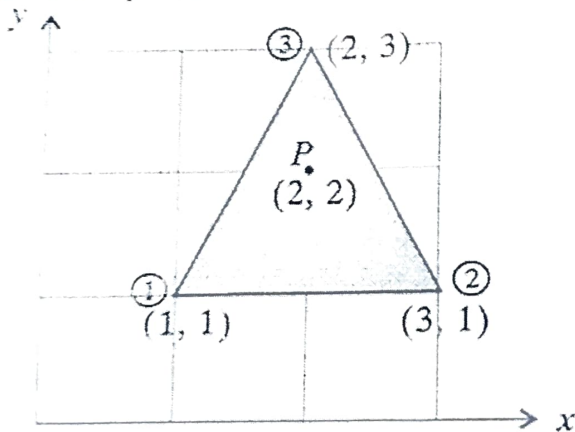


b) For the triangular element shown in figure below fig

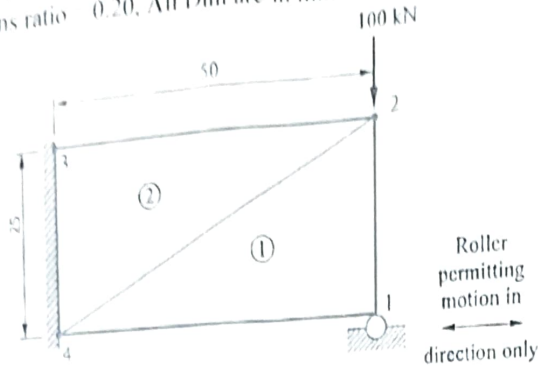
$$U_1 = 2, U_2 = 3, U_3 = 5,$$

$$V_1 = 1, V_2 = 2, V_3 = 3$$

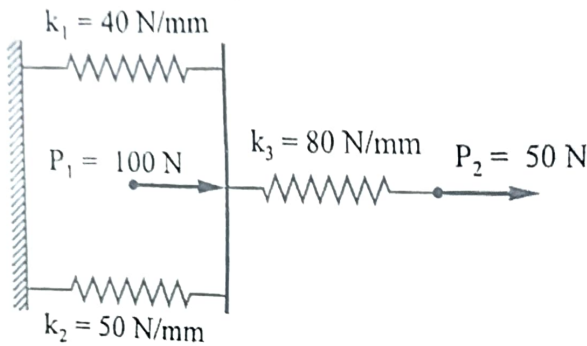
Where U, V are displacement in x and y at node 1, 2, 3 respectively.
Obtain the displacement of point P . [08]



Q5 a) For 2D loaded plate shown in below figure below. Determine the displacements of nodes 1 and 2 and the element stresses using the plane stress conditions. Assume thickness as 12 mm, $E = 235 \text{ GPa}$ and poisons ratio $\nu = 0.20$. All Dim are in mm [12]



b) A three spring system with stiffness (k) and loads (p) are shown in figure. Calculate the displacement at nodal points. [08]



Q6 a) Find natural frequency of axial vibration of a bar of uniform cross section of 20 mm^2 and length 1 m. Take $E = 210 \text{ GPa}$ and density $= 8000 \text{ kg/m}^3$. Assuming mass to be uniformly distributed across the element. [8]

b) A beam having cross sectional of radius 10 mm and length of 100 mm, with young's modulus $2.5 \times 10^5 \text{ N/mm}^2$ and poison's ratio 0.3 is fixed at one end, and a transverse load of 100 N is applied at the other end. Calculate the displacement at various node points. [12]