(3 Hours)

Total marks: 80

N.B.: 1) **Question No. 1** is **compulsory.**

2) Attempt **any three** questions out of remaining five questions.

3) Assume suitable data if required.

Q1 Solve any 4 **[Each 5 Marks]**

i) Why Finite Element Method is an approximate solution? Explain in brief how the accuracy of FEM results improve.

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

iii) Derive the shape function for One Dimensional Linear Element in Natural Coordinates.

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

v) What is the significance of Jacobian Matrix in FEA? Explain in brief.

vi)What do you mean by Consistent and Lumped mass matrix? Explain in brief with their importance.

Q2 a) Solve the following differential equation using Galerkin Method. [12]

$$-\frac{d}{dx}\left[(x-1)\frac{du}{dx}\right] = x^2\,; \quad 3 \le x \le 5$$

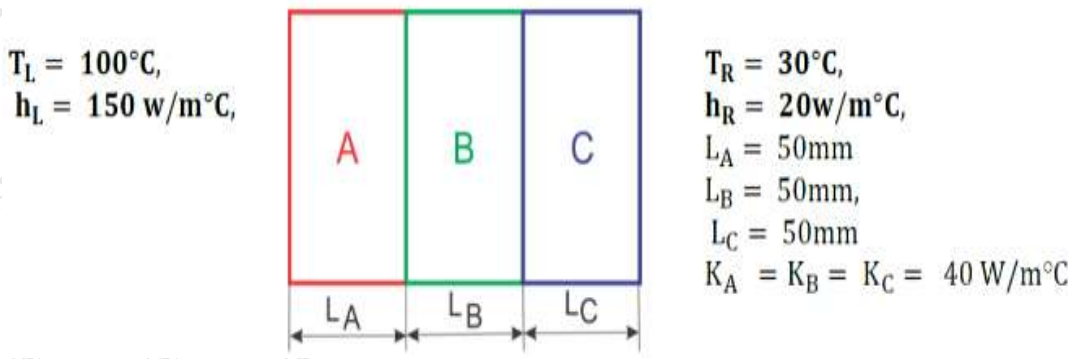
Boundary Conditions are; $u\,(5) = 10\ and\ u'(3) = 5$

Also compute the value of primary (u) variable at x = 3.5, 4.5

b) What are the sources of Errors in FEA? [04]

c) What is Boundary Condition? Explain its type in brief. [04]

Q3 a) Find the temperature at interfaces and heat transfer per unit area through the wall. [10]



Where K- denotes thermal conductivity, h- denotes heat transfer coefficient and T-temperature

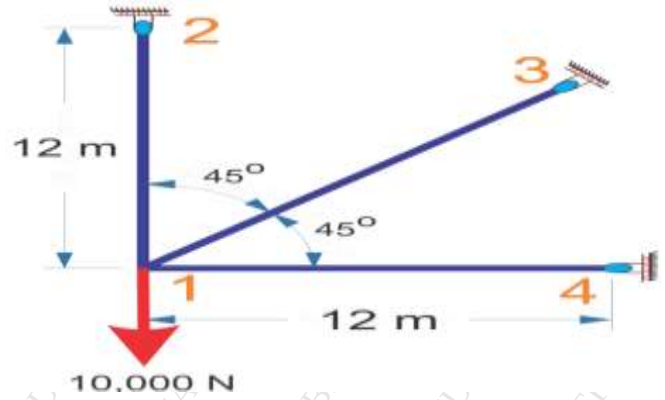
b) Develop the finite element equation for the most general element using Rayleigh Ritz Method for vertical bar with axial loading. The governing differential equation is given below [10]

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

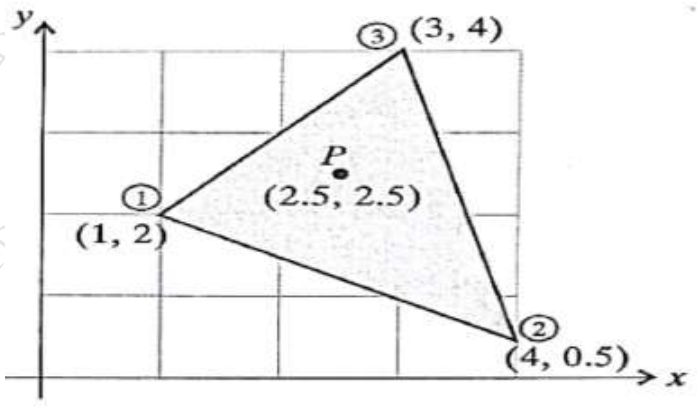
Where f is the weight of the bar. Consider one end of the bar to be fixed and other end free.

Q4 a) For the plane truss shown in figure. [12]

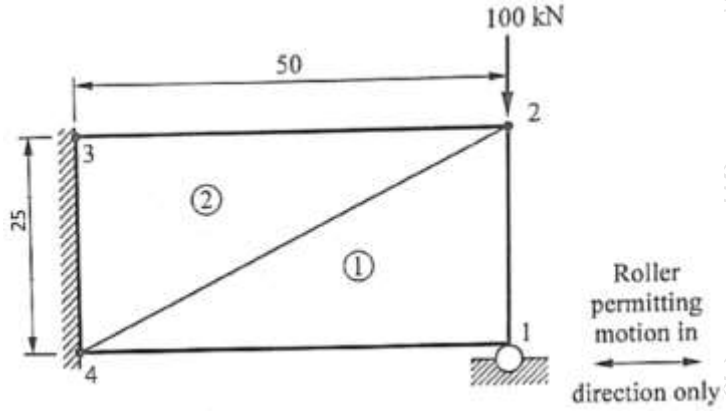
(i) Determine the displacement at nodes
(ii) Determine the stresses in each bar.



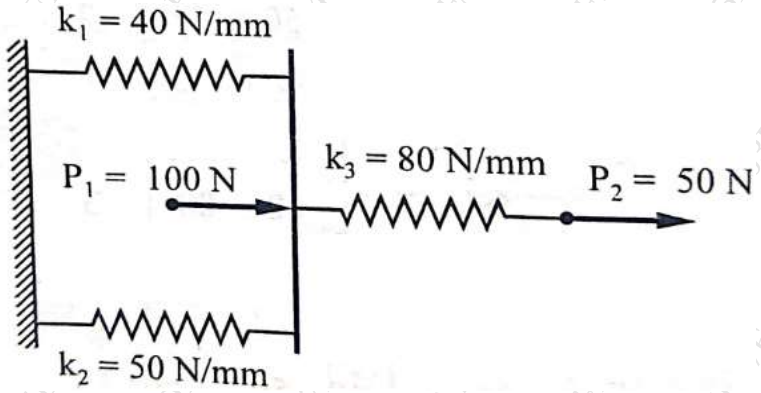
b) The triangular element used for ground water flow simulation is shown in below figure. The nodal coordinates are (x_1 = 1, y_1 = 2), (x_2 = 4, y_2 = 0.5), (x_3 = 3, y_3 = 4). The nodal values of hydraulic heads { Φ} at these nodes are [3.5, 2.2, 4.4] respectively. Find the values of hydraulic head Φ at point (2.5, 2.5) [08]



Q5 a) For 2D loaded plat 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 10 mm, E = 225 GPa and poisons ratio = 0.25, All Dim are in mm [12]

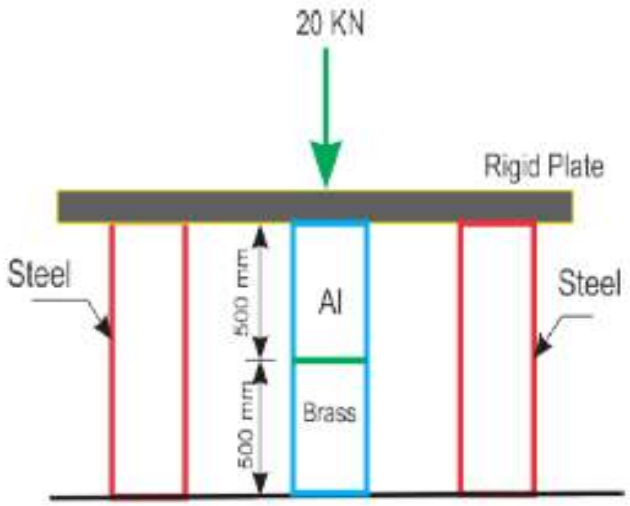


b) A three spring system with stiffness (k) and loads (p) are shown in figure. Calculate the displacement at nodal points. [08]



Q6 a) For a uniform cross-section bar shown in fig. below of length L = 1m made up of a material having E = 2 x 10^{11}N/m^2 and ρ = 7800 kg/m^3. Estimate the natural frequencies of axial vibration of the bar using both consistent mass matrices. Use a two element mesh. Given A = 30 x 10^{-06} m^2 [08]

b) For the given steel block supporting rigid plates shown in below fig, [12]
Determine displacement, Stress in the blocks.



Properties	Steel	Aluminium	Brass
C/s Area (mm^2)	200	370	
$E\ (N/mm^2)$	2×10^5	7×10^4	8.8×10^4

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