(3 Hours) **Total marks 80**

- **Question No.1 is compulsory.**
- Solve **ANY THREE** questions from the **remaining** five questions.
- Figure to the right indicates full marks.
- Assume suitable data wherever required, but justify the same.

Q. 1 Solve **ANY FOUR** questions from the following. **20**

a) Distinguish between h and p methods of mesh refinement with necessary illustrations. **5**

b) Distinguish between plane stress and plane strain conditions. **5**

c) Describe the significance of principle of minimum potential energy. **5**

d) Explain convergence criteria in FEM. **5**

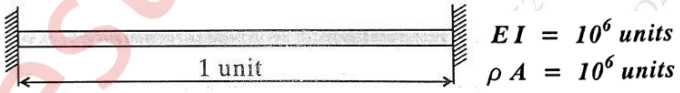
e) Explain lumped mass matrix, consistent mass matrix and HRZ lumping scheme with suitable examples. **5**

Q. 2 **a)** Solve following differential equation using galerkin method **10**

$$\frac{d^2u}{dx^2} - 9\,u = x^3 \quad ; \qquad 0 \le x \le 1$$

Given boundary conditions are: $u(0) = 0$ and $u(1) = 2$. Determine u (0.5).

b) Determine the two natural frequencies of transverse vibrations of a beam fixed at both ends a shown in fig. Use Consistent Mass Matrix. Take EI = 10^6 units and ρA = 10^6 units. **10**

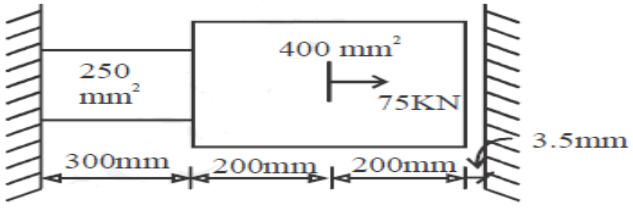


Q. 3 **a)** Solve the following differential equation by Rayleigh Ritz method. **10**

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

Given Boundary Conditions are: $y(0) = y(1) = 0$

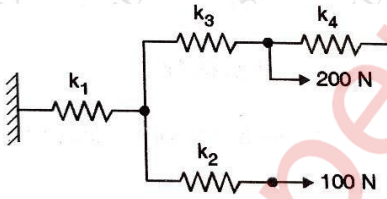
b) Determine the unknown reactions, displacement and element stresses for the stepped bar shown in the figure below (E = 200 GPa). **10**



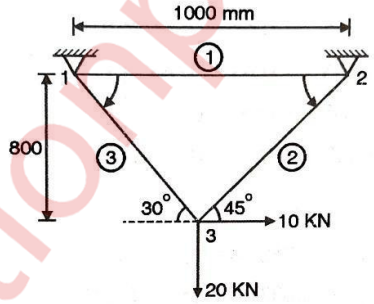
Q. 4 **a)** Find the natural frequency of axial vibrations of a bar of uniform cross section of 50 mm^2 and length of 1 meter using consistent mass matrix and compare with exact frequencies. Take E = 200 GPa and density = 7860 kg/m^3. Take two linear elements. **10**

b) The triangular element has nodal coordinates (10, 10), (40, 20) and (30, 50) for nodes 1, 2 and 3 respectively. For the point P located inside the triangle, determine x and y coordinates if the shape functions, N_1= 0.15 and N_2= 0.25. **10**

Q. 5 **a)** Determine the displacement at nodes by using principle of minimum potential energy approach **10**



b) Find nodal displacement, reaction forces and stresses in each element for a truss given below. Take E= 210 GPa and A = 100 mm^2. **10**



Q. 6 **a)** A steel fin of diameter 2 cm, length 10 cm and thermal conductivity 80 W/m-K is exposed to ambient air at 40^0C with a heat transfer coefficient of 100 W/m^2-K. One end of the fin is at a temperature of 540^0C and the other end is insulated. Governing DE is; **10**

$$\frac{d^2\theta}{dx^2} - m^2\theta = 0 \qquad \theta = T - T_\infty$$

Where $m^2 = \frac{hp}{KA}$ and $\Omega = 0 \le x \le L$

P = Perimeter, A = Cross section area

h = Heat transfer coefficient

K = Thermal conductivity, and T_∞ = Ambient temperature

Take three liner elements of equal lengths and solve to get temperatures at these intermediate points.

b) Explain the procedure of Rayleigh-Ritz method based on principle of stationary total potential. **10**

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