

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

Q.1 Attempt any **four**

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- a) Explain different types of Boundary conditions giving examples.
- b) Write element matrix equation in the following fields explaining each term:
 - i. 1D steady state, heat transfer by conduction
 - ii. Torsion Analysis
- c) Explain Subparametric, Isoparametric and Superparametric elements.
- d) Explain plane stress and plane strain conditions with examples.
- e) Explain the significance of shape functions.

Q.2

- a) Solve the following differential equation using Method of least square and point Collocation method.

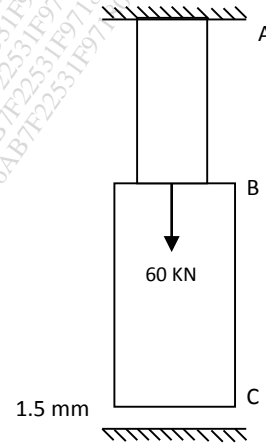
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(Assume collocation points $x = 0.25$ and 0.5)

$$\frac{d^2\Phi}{dx^2} - \Phi = x; \quad 0 \leq \phi \leq 1; \quad \phi(0) = 0, \phi(1) = 0$$

Compare answer with exact solution at $x = 0.5$

- b) A bar ABC shown in figure is subjected to a load of 60kN at B with a clearance of 1.5mm below the section at C. Area of AB is 150 mm^2 and length is 1.5m. Area of BC is 240 mm^2 and length is 3 m. Compute stresses in AB and BC. $E=200 \text{ GPa}$.



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Q.3

- a) Develop the Finite Element Equation for the most general element using Rayleigh Ritz method for a vertical bar with axial loading. The governing differential equation is

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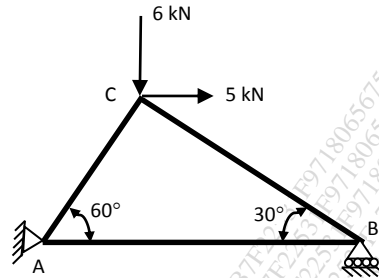
$$\frac{d}{dx} \left(EA \frac{du}{dx} \right) + f = 0 \quad ; \quad 0 \leq x \leq L$$

where f is the weight of the bar per unit length.

- b) Derive the shape function for a rectangular element in local coordinate system and show its variation over the element.

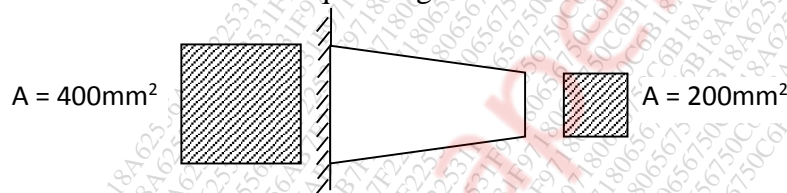
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- Q.4 a) Compute the stress developed in the members of the truss shown in figure. $E=200$ GPa. Area of the member AB is 20 cm^2 and its length is 5m. Members BC and AC have the same area and is equal to 25 cm^2 . **10**



- b) What do you mean by consistent and lumped mass matrices? Derive the same for linear bar element. **10**

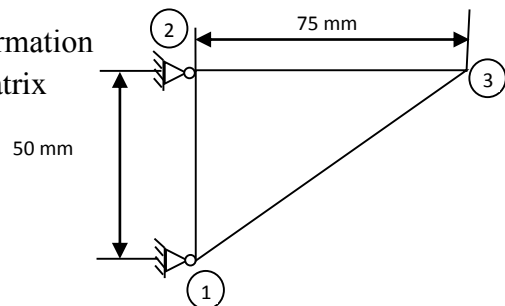
- Q.5 a) Evaluate the natural frequencies for the bar with varying cross sections shown in figure. $L = 200$ mm, $E = 200$ GPa and $\rho = 8000 \text{ kg/m}^3$. Consider two elements of equal lengths. **10**



- b) A quadrilateral element is defined by the coordinates (1,4), (4,2), (5,6) and (2,7). The temperatures at the nodes are 20°C , 30°C , 40°C and 25°C respectively. Determine the temperature at a point which has local coordinates $\xi = 0.123$ and $\eta = -0.369$ and also its cartesian coordinates. **10**

- Q.6 a) A triangular plate of size $75 \text{ mm} \times 50 \text{ mm} \times 12.5 \text{ mm}$ is as shown in figure. The modulus of elasticity and Poisson's ratio for plate material are $200 \times 10^3 \text{ N/mm}^2$ and 0.25 respectively. Upon loading of the plate, the nodal deflections at node 3 were found to be 0.01552 mm and -0.0004 mm in x and y direction respectively. Model the plate with CST element and determine : **12**

- i) The Jacobian for (x,y) - (ξ,η) transformation
- ii) The strain-displacement relation matrix
- iii) The stress in plate



- b) Explain Convergence criteria. What do you understand by h & p method of Finite Element Analysis? **08**