**Paper / Subject Code: 89023 / Finite Element Analysis**
T.E. SEM VI / MECH / CHOICE BASE / MAY 2019 / 22.05.2019

**(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

Q.1 Attempt any **four** **20**

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.

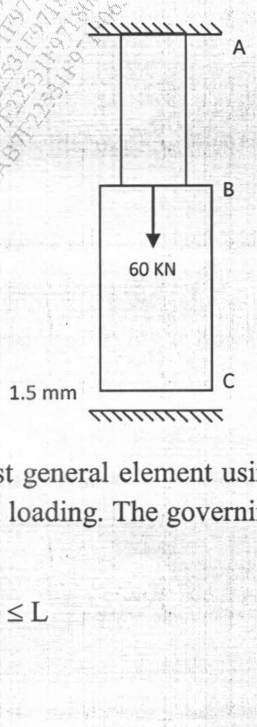
Q.2 a) Solve the following differential equation using Method of least square and point Collocation method. **10**

( Assume collocation points x = 0.25 and 0.5)

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

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 GPa. **10**



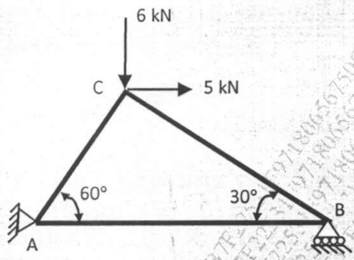

Q.3 a) Develop the Finite Element Equation for the most general element using Rayleigh Ritz method for a vertical bar with axial loading. The governing differential equation is **10**

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

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

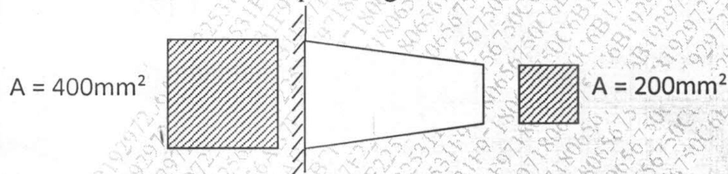
b) Derive the shape function for a rectangular element in local coordinate system and show its variation over the element. **10**

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**

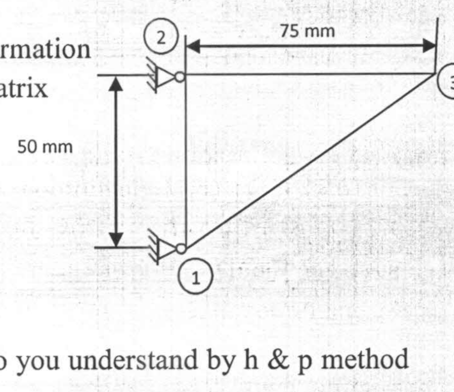
Q.5 a) Evaluate the natural frequencies for the bar with varying cross sections shown in figure. $L = 200$ mm, $E = 200$ GPa and $\rho = 8000$ kg/$m^3$. Consider two elements of equal lengths. **10**




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 75mm x 50 mm x 12.5 mm is as shown in figure. The modulus of elasticity and Poisson's ratio for plate material are 200 x $10^3$ N/$mm^2$ and 0.25 respectively. Upon loading of the plate, the nodal deflections at node 3 were found to be 0.01552mm 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)-($\xi$,$\eta$) 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**

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