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Sixth Semester B.E. Degree Examination, June/July 2019
Finite Element Methods

Time: 3 hrs.

Max. Marks:100

**Note: Answer any FIVE full questions, selecting
atleast TWO questions from each part.**

PART – A

- 1 a. Derive the 3D equations of equilibrium in elasticity subjected to body force and traction force. (08 Marks)
- b. What is FEM? Explain the basic steps involved in FEM. (08 Marks)
- c. Explain node numbering scheme and its effect on the half band width. (04 Marks)
- 2 a. Determine the deflection of a cantilever beam of length 'L' and loaded with a vertical load 'P' at the free end by Rayleigh Ritz method use a trial function $Y = a \left(1 - \cos \frac{\pi x}{2h} \right)$. (10 Marks)
- b. Use Galerkin's method and obtain an approximate solution of differential equation.

$$\frac{d^2 y}{dx^2} - 10x^2 = 5, \quad 0 \leq x \leq 1$$
 with boundary conditions $y(0) = y$ and $y(1) = 0$. (10 Marks)
- 3 a. Derive shape function for 1D bar element in global co-ordinate system. (08 Marks)
- b. Derive an expression for Jacobian matrix for a three noded CST element. (08 Marks)
- c. Explain 2D - Pascal's triangle. (04 Marks)
- 4 Consider the thin plate shown in Fig.Q4. The plate has a uniform thickness $t = 1$ mm, Young's modulus $E = 200$ GPa and weight density $\rho = 76.6 \times 10^{-6}$ N/mm³. In addition to its weight, the plate is subjected to a point load $P = 100$ N at its mid point.
 - a. Model the plate with two finite elements.
 - b. Write down expressions for the elemental stiffness matrices and force vector.
 - c. Assemble the structural stiffness matrix 'K' and global load vector 'F'.
 - d. Using elimination approach, solve for the global displacement vector Q.
 - e. Evaluate the stress in each element.
 - f. Determine the reaction force at the support. (20 Marks)

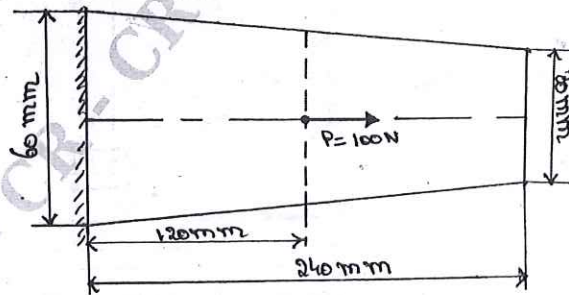


Fig.Q4

PART - B

- 5 a. With a neat sketch explain isoparametric, sub parametric and super parametric elements. (06 Marks)
 b. Write a note on higher order elements used in FEM. (06 Marks)
 c. Using two point Gaussian quadrature formula evaluate the following integral.

$$I = \int_{-1}^{+1} \int_{-1}^{+1} (r^2 + 2rs + s^2) dr ds$$

(08 Marks)

- 6 a. List the assumptions made in analysis of truss and also obtain an expression for stiffness matrix of a truss element. (10 Marks)
 b. For the two bar truss shown in Fig.Q6(b), determine the nodal displacements and stress in each member. Take $E = 200 \text{ GPa}$. (10 Marks)

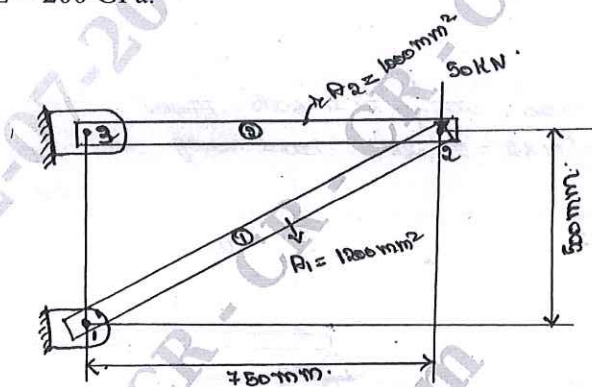


Fig.Q6(b)

- 7 a. Derive elemental stiffness matrix for a beam element in global coordinate system. (10 Marks)
 b. Define Hermite shape function and derive the Hermite shape function for a beam element. (10 Marks)
- 8 a. For the brick wall shown in Fig.Q8(a), the inner surface temperature is 28°C and outer surface is exposed to cold air at -15°C . Determine the temperature distribution in steady state, within the wall by considering two elements, one dimensional heat flow elements. What is heat flux through the wall? (10 Marks)

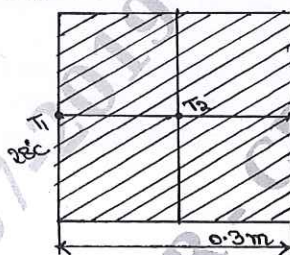


Fig.Q8(a)

$k = 0.7 \text{ W/m}^\circ\text{C}$
 $h = 40 \text{ W/m}^2\text{C}$
 $T_{\infty} = -15^\circ\text{C}$

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- b. For the beam element shown in Fig.Q8(b), determine deflection under the given load. Take $E = 2 \times 10^8 \text{ kN/m}^2$ and $I = 4 \times 10^{-6} \text{ m}^4$. (10 Marks)

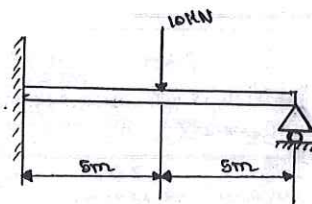


Fig.Q8(b)
