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15AE651

Sixth Semester B.E. Degree Examination, July/August 2021 Finite Element Method

Time: 3 hrs.

Max. Marks: 80

Note: Answer any FIVE full questions.

- 1
 - a. Derive equilibrium equations for the 3D state of stress in rectangular coordinate system. (10 Marks)
 - b. Explain plane stress and plane strain with stress-strain relationship and give examples for each. (06 Marks)

- 2
 - a. Sketch the different types of elements used in finite element analysis. (06 Marks)
 - b. Using the Galerkin's method, determine the expression for the displacement of a cantilever beam shown in Fig Q2(b).

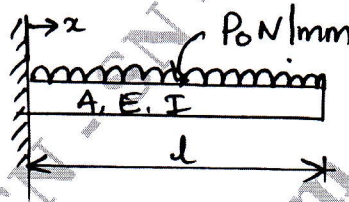


Fig Q2(b)

(10 Marks)

- 3
 - a. Derive shape functions for 1D bar element is NCS. (08 Marks)
 - b. Consider the three bar truss shown in Fig Q3(b). Determine the nodal displacement and stresses in each member. Find the support reactions also. Take $A_1 = 1500\text{mm}^2$; $A_2 = A_3 = 2000\text{mm}^2$ and $E = 200\text{GPa}$.

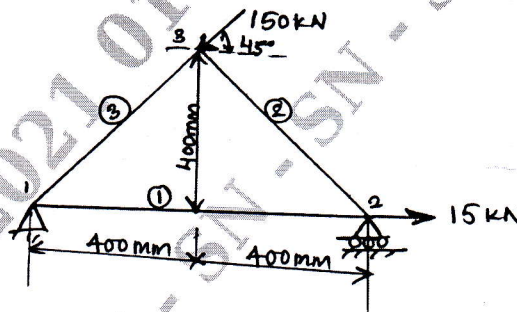


Fig Q3(b)

(08 Marks)

- 4 Fig Q4 show a simply supported beam subjected to a uniformly distributed load. Obtain the maximum deflection. Take $E = 200\text{GPa}$ and moment of Inertia $I = 2 \times 10^6\text{mm}^4$.

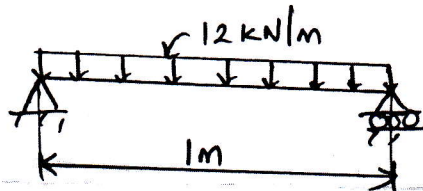


Fig Q4

(16 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and/or equations written eg. 42+8 = 50, will be treated as malpractice.

- 5 a. Derive shape function for nine node rectangular element in Natural coordinate system. (10 Marks)
 b. Determine the Cartesian coordinate of the point $p(\xi = 0.8, \eta = 0.9)$ as shown in Fig Q5(b).

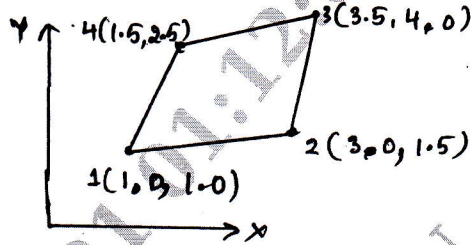


Fig Q5(b)

(06 Marks)

- 6 a. Derive shape functions for a tetrahedral element in Natural coordinate system. (08 Marks)
 b. Derive shape functions for a hexahedral element in natural coordinate system. (08 Marks)

- 7 Briefly explain the following :
 i) I_{so} , sub and super parametric elements
 ii) Structure of computer program for FEM analysis
 iii) Finite element softwares.

(16 Marks)

- 8 a. What is axisymmetric element? Where do you use? (04 Marks)
 b. Formulate strain displacement matrix for an axisymmetric linear triangular element. (12 Marks)

- 9 a. Derive the shape functions for 1D heat conduction element in global-coordinate system. (08 Marks)
 b. Determine the temperature distribution in one dimensional fin shown in Fig Q9(b).

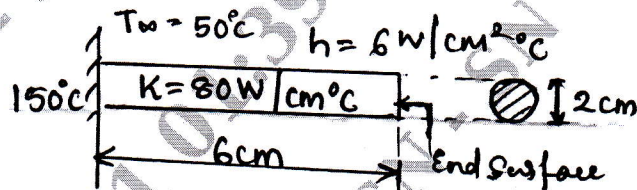


Fig Q9(b)

(08 Marks)

- 10 a. Derive element conductivity matrix for 1D heat conduction. (05 Marks)
 b. Briefly explain Hamilton's principle. (03 Marks)
 c. Determine the temperature distribution and heat transfer through an iron fin of thickness 5mm, length 50mm and width 1000mm. The heat transfer coefficient around the fin is $10\text{W/m}^2\text{K}$ and ambient temperature is 28°C . The base of the fin is at 108°C . Take $K = 50\text{W/mK}$. Use two elements. (08 Marks)
