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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M.TECH. DEGREE EXAMINATION, APRIL/MAY 2018

Branch: Civil Engineering

Stream: Structural Engineering

01CE6104 Finite Element Method

Answer ***any two full*** questions from ***each*** part

Limit answers to the required points.

Max. Marks: 60 Duration: 3 hours

PART A

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1. a. If the displacement field in a body is specified as $u = (x^2 + 3)10^{-3}, v = (3y^2 z)10^{-3}$, $w = (x + 3z)10^{-3}$. Determine the strain component at a point whose co-ordinates are (1, 2, 3). (3)

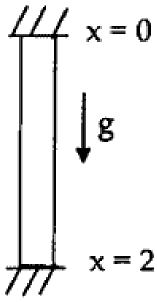
   b. Determine the maximum displacement in a simply supported beam of span 6 m and subjected to two equal and opposite moments of 50 kNm at the supports by Galerkin's method and compare the solution with the exact solution. (6)

2. a. State and derive the principle of virtual work. (4)

   b. Explain the step-by-step procedure involved in the finite element analysis of a problem. (5)

3. a. What are all the requirements to be satisfied with regard to the displacement function so as to arrive at a solution converging to the exact solution on refining the mesh. (5)

   b. Use Rayleigh-Ritz method to find the displacement at the midpoint of the rod due to a body force/unit volume of 'g'. Take g = A = E = 1.



(4)

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PART B

4. a. Develop the shape functions for a beam element with 2 degrees of freedom per node and plot the same. (6)

   b. Differentiate between iso-, super- and sub-parametric elements. (3)

5. a. Develop the consistent nodal load vector for the continuous beam ABCD with the following details. AB = 5 m, BC = 6 m, CD = 4 m. AB is subjected o a UDL of 20 kN/m, BC is subjected to a moment of 50 kNm at 4 m from B and CD is subjected to a concentrated load of 30 kN at 3 m from C. (6)

   b. Evaluate the shape functions at the interior point ' P ' for the CST element having the following co-ordinates. Node 1 (1.5, 2), Node 2 (7, 3.5), Node 3 (4, 7) and point P (3, 4). (3)

6. a. Develop the shape functions for the quadratic serendipity element and plot the same for representative nodes. (7)

   b. Write down the basic displacement function that can be used to represent the displacement along X-direction for a quadratic Lagrange element. (2)

PART C

7. a. Explain how the degrees of freedom associated with the interior nodes of an element are condensed out. (5)

   b. Define semi-bandwidth and skyline. (3)

   c. Suggest a suitable order of Gauss integration for the evaluation of stiffness matrix for a plane bilinear element. Justify your answer. Also write down the respective sampling points and weights. (4)

8. a. Explain the test to be conducted for checking the validity of a finite element formulation. (6)

   b. Evaluate $\int_{-1}^{1} N^T N d\varepsilon$ for an one dimensional quadratic element to illustrate the application of Gauss quadrature technique. (6)

9. a. What are the various plate bending elements used in FEM? (5)

   b. Solve the following system of equations by LDL^T technique.

   $5x_1+3x_2+8x_3 = 134$

   $3x_1+9x_2+15x_3 = 240$

   $8x_1+15x_2+10x_3 = 268$ (7)

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