Code No: **R1641033** **R16** **Set No. 1**

IV B.Tech I Semester Regular/Supple Examinations, March - 2021

FINITE ELEMENT METHODS

(Common to Mechanical Engineering and Automobile Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any FOUR questions from Part-B
****

PART–A *(14 Marks)*

1. a) What is plane stress? Give example. [3]
   b) Define banded matrix. What is half band width? [2]
   c) Write the hermite shape functions of 2 Node beam element. [2]
   d) Write the advantages of axisymmetric formulation. [3]
   e) Write the shape functions of 1D cubic element. [2]
   f) What is dynamic analysis? [2]

PART–B *(4x14 = 56 Marks)*

2. a) Apply the principle Rayleigh–Ritz method and evaluate the approximate deflection of a fixed beam of length '*L*' subjected to a point load '*p*' at the center of the span. [9]
   b) Explain the basic steps of FEM. [5]

3. a) Consider a simple one dimension structure with three elements, explain the process of stiffness matrix and load vector assembly. [7]
   b) Write the conditions for selection of interpolation function. Explain about Pascal triangle. [7]

4. Given the three-bar structure subjected to the prescribed load at point D equal to 10^3 N as shown in Figure.1. The Young's modulus is E = 10^{11} N/m^2, the cross-sectional area of the bar BC is 2 x 10^{-2} m^2 and that of BD and BF is 10^{-2} m^2. Note that the point D is free to move in the x-direction. Coordinates of joints are given in meters. [14]
   i) Construct the global stiffness matrix and load matrix.
   ii) Solve for the unknown displacements at point B and displacement in the x-direction at point D.
   iii) Find the stresses in the three bars.

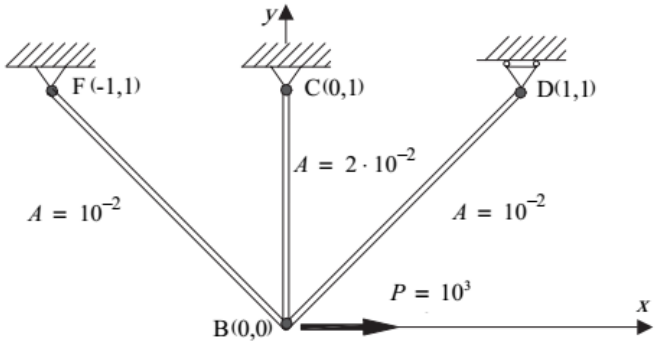

Figure.1

5. a) Derive the strain displacement matrix of a 2D three node axisymmetric element. [10]
   b) Write a short note on CST and LST elements. [4]

6. a) Derive and plot the shape functions of four node quadrilateral element. [8]
   b) Evaluate the integrals $x^2 + Cos(x/2)$ between the limits -1 and +1 using Three - point Gaussian quadrature. Compare the result with the result of exact solution. [6]

7. Find the temperature distribution in the fin shown in Figure.2 by including the effect of convection from the end surface A. Consider three elements. [14]

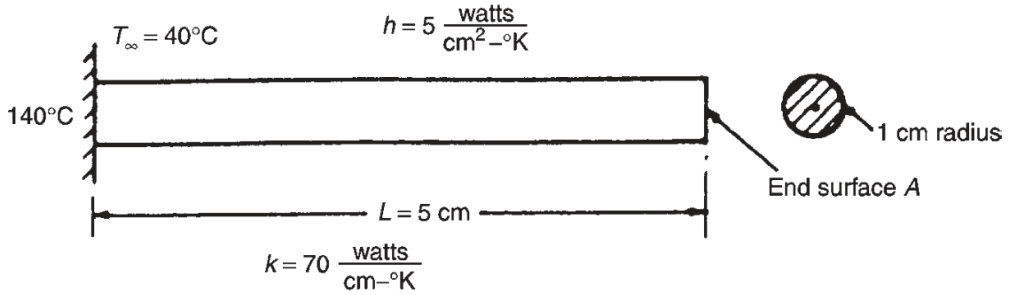

Figure.2

Code No: **R1641033** **R16** **Set No. 2**

IV B.Tech I Semester Regular/Supple Examinations, March - 2021

FINITE ELEMENT METHODS

(Common to Mechanical Engineering and Automobile Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any FOUR questions from Part-B
*****

PART–A *(14 Marks)*

1. a) What is plane strain? Give example. [3]
   b) Write a short note on Node numbering. [2]
   c) Differentiate between truss and beam. [2]
   d) Why three node 2D Triangular element called CST element. [3]
   e) Write the shape functions of 1D quadratic element. [2]
   f) What is lumped mass matrix? [2]

PART–B *(4x14 = 56 Marks)*

2. a) Evaluate the displacements and reactions at the supports for the loaded structure given in figure.1. [10]

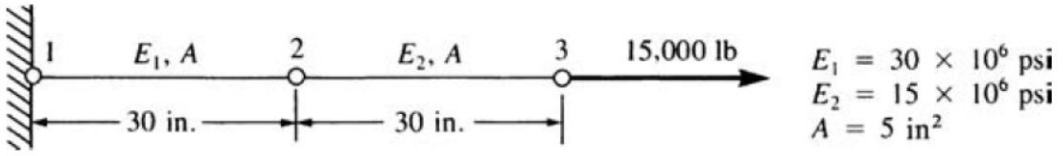

Figure.1

   b) Explain the concept of minimum potential energy. [4]

3. a) Explain Penalty approach for the treatment of boundary conditions. [8]
   b) Discuss about element shapes and discretization procedures of FEM. [6]

4. Derive the expression for stiffness matrix and load vector for UDL case of two node beam element. [14]

5. For the triangular plate shown in figure.2, determine the deflection at the point of load application and also stress induced in the plate using a one element model by considering it as plane stress problem. [14]

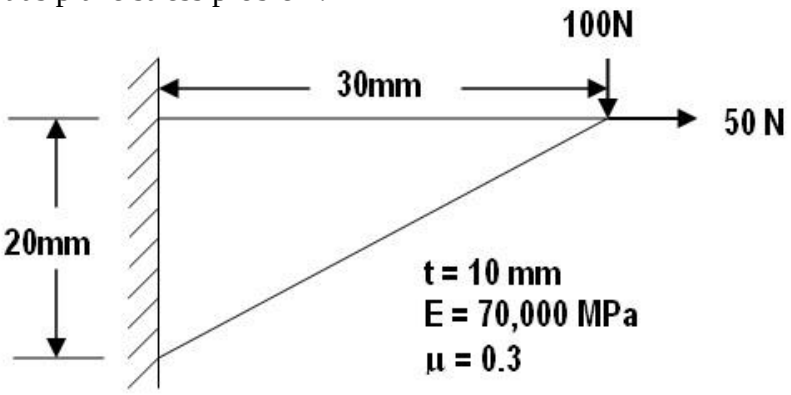

Figure.2

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6. a) Evaluate the jacobian matrix for the isoparametric quadrilateral element shown in figure.3 [9]

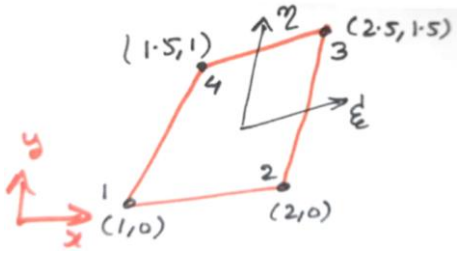

Figure.3

b) Explain the importance of numerical integration in FEM. [5]

7. a) For the one-dimensional composite bar shown in Figure.4, determine the interface temperatures. For element 1, K_{xx}= 150 W/m ^{0}C, for element 2, K_{xx}= 100 W/m ^{0}C; and for element 3, K_{xx}= 50 W/m ^{0}C. Let A = 0.1 m^2.The left end has a constant temperature of 100 ^{0}C and the right end has a constant temperature of 300 ^{0}C. [10]

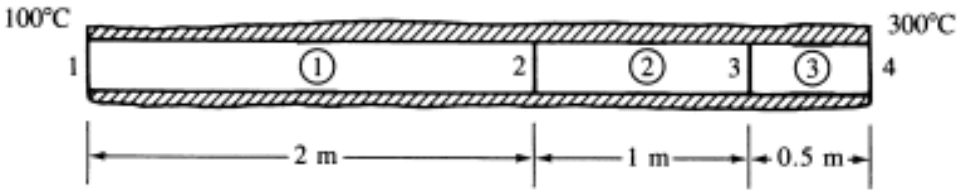

Figure.4

b) Explain about free vibration analysis. [4]

Code No: **R1641033** **R16** **Set No. 3**

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FINITE ELEMENT METHODS

(Common to Mechanical Engineering and Automobile Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any FOUR questions from Part-B
****

PART–A *(14 Marks)*

1. a) Write the applications of FEM. [3]
   b) What are local and global coordinates? [2]
   c) Write the load vectors for UDL and concentrated load at the center for 2 Node beam element. [2]
   d) Under what conditions a problem can be treated as axisymmetric? [3]
   e) Write the stress strain relation for 2D plane stress case. [2]
   f) What is steady state heat transfer? [2]

PART–B *(4x14 = 56 Marks)*

2. a) A cantilever beam of span L is subjected to a point load P at the free end. Derive the expression for deflection at the free end using Rayleigh Ritz method Take trail function as [10]

$$y = a_0 + a_1 x + a_2 x^2 + a_3 x^3$$

   b) What is Weighted residual method? Explain any one Weighted residual method. [4]

3. a) Explain elimination approach for the treatment of boundary conditions. [10]
   b) Write the convergence requirements. [4]

4. a) For the plane trusses shown in the figure.1, determine the horizontal and vertical displacements of node 1 and the stresses in each element. All elements have E=210 GPa and A=4.0 X 10^{-4} m^2. [14]

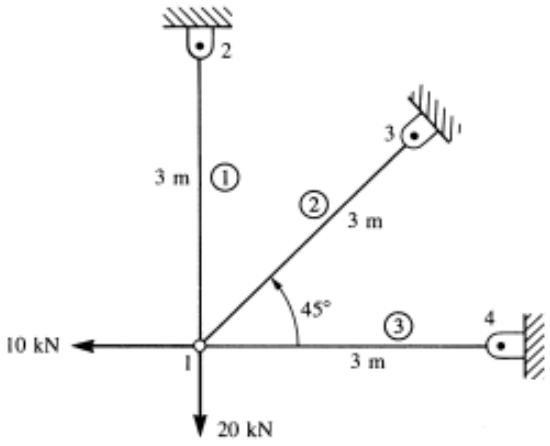

Figure.1

5. a) Derive the shape functions of a triangle using area coordinates. [9]
   b) Evaluate the shape functions N_1, N_2 & N_3 at the interior point P for the triangular element shown in figure.2. [5]

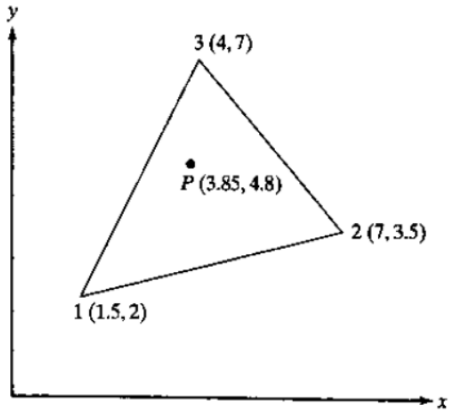

Figure.2

6. a) For the isometric element shown in figure.3, the global coordinates of point P are (6,4). The loads 10 kN and 12 kN are acting in x and y directions on point P. Evaluate the nodal equivalent forces. [9]

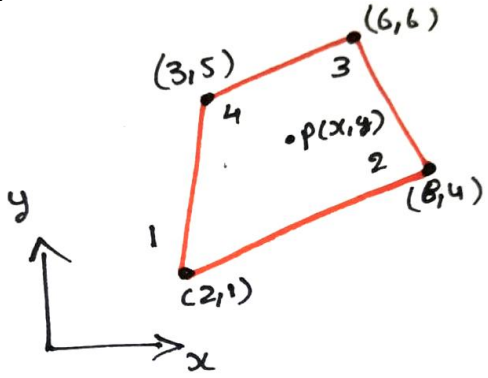

Figure.3

   b) Discuss about numerical integration with an example. [5]

7. Evaluate the natural frequencies of a beam clamped at both ends. Consider two finite elements for evaluation. Given the Moment of Inertia 100 mm^4, Length of the beam is 2000 mm, E = 2 x 10^5 N/mm^2, Density = 7000 kg/m^3. [14]

Code No: **R1641033** **R16** **Set No. 4**

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Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any FOUR questions from Part-B
*****

PART–A *(14 Marks)*

1. a) Write the shape functions of 2 node 1D bar element. Plot the shape functions. [3]
   b) What is geometric isotropy? [2]
   c) Write the stiffness matrix of 2 node plane truss element. [2]
   d) What are area coordinates? [3]
   e) What is a LST element? [2]
   f) What does eigen values and eigen vectors represent in free vibration analysis? [2]

PART–B *(4x14 = 56 Marks)*

2. a) In the figure.1 shown, a load P = 60 X 10^3 N is applied. Determine the displacement field , stress and support reactions in the body. Take E = 20 X 10^3 N/mm^2. [8]

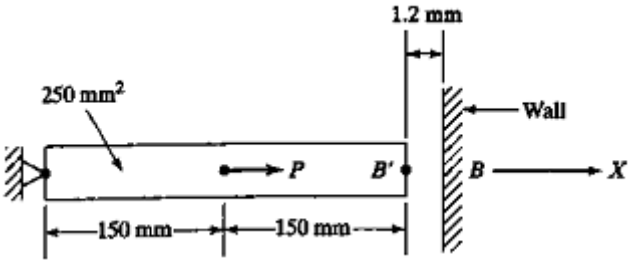

Figure.1

   b) Explain about the following with an example [6]
   i) Collocation method ii) Least square method.

3. a) What is domain discretization? Discuss about element shapes and discretization procedures. [8]
   b) Explain about Mesh generation and node numbering. [6]

4. A Beam of length 10 m as shown in the figure.2 is subjected to a moment of 50000 Nm (Clockwise) at the midpoint. Assuming two elements, evaluate the displacement. Take E = 200 GPa, The left half of the beam is of rectangular cross section of width 300 mm and depth 200 mm. The moment of inertia of right half of the beam is twice that of left side. [14]

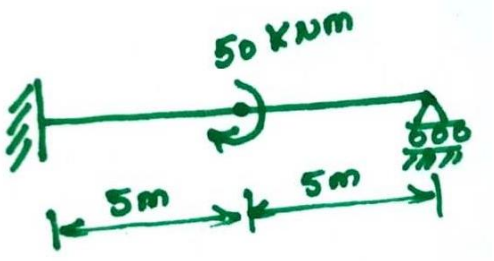

Figure.2

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5. Derive the Strain displacement matrix and the expression for stiffness of a CST element. [14]

6. a) A four node quadrilateral is shown in the figure.3. The (x,y) coordinates of each node are given. The element displacement vector Q is given as $Q=[0, 0, 0.2, 0, 0.15, 0.1, 0, 0.05]^T$. Find the following. [10]
   i) The x, y coordinates of point P whose location in the master element is given by $\xi = 0.5$ and $\eta = 0.5$.
   ii) The *u, v* displacement of the point P.

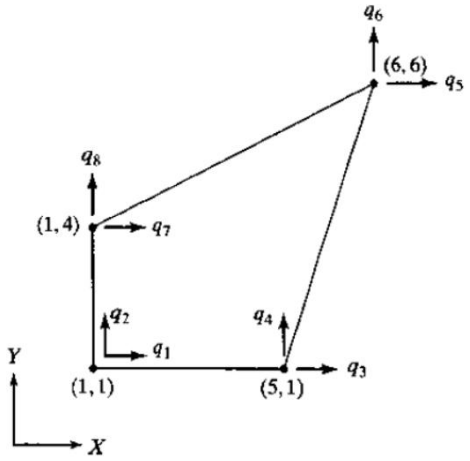

Figure.3

   b) Evaluate the given integral using Gauss quadrature method and compare with exact solution. [4]

$$\int_2^4 (3x^2 + 2x + 5)\, dx$$

7. a) For the composite wall shown in figure.4, determine the interface temperatures considering three elements. [10]

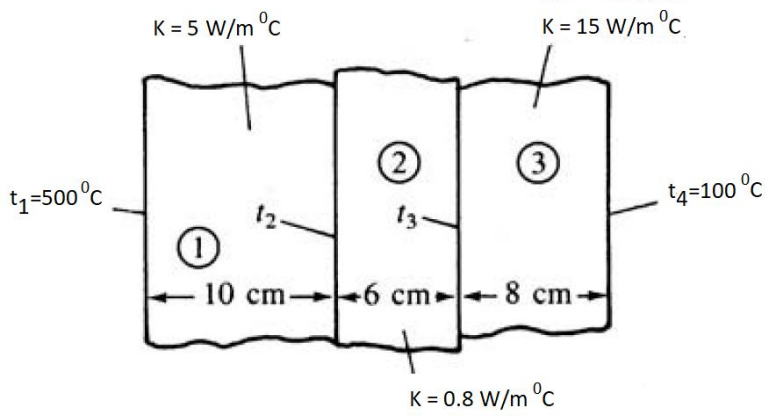

Figure.4

   b) Derive the consistent mass matrix of 2 node bar element. [4]

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