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

IV B.Tech I Semester Regular Examinations, October/November - 2019

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 the principle of minimum potential energy? Write the expression for potential energy. [3]
   b) Write a short note on Banded matrix. [2]
   c) Distinguish between bar and a truss elements. [2]
   d) Sketch two examples where they can be considered as axisymmetric problems. [2]
   e) Derive the shape functions of 1D quadratic element. [3]
   f) How do you understand the Eigen values in vibration problem? [2]

PART–B *(4x14 = 56 Marks)*

2. a) Discuss in detail the general steps involved in Finite Element Method considering a simple one dimensional structure. [8]
   b) If a displacement field is described by
   $u = (-x^2 + 2y^2 + 6xyz + 2z^2 + 4yz)\ 10^{-4}$
   $v = (3x + 6y - y^2 + 6yz + 3z)\ 10^{-4}$
   $w = (x^2 + 2y^2 + z^2 - 2z + 2xyz)\ 10^{-4}$
   Determine the strain field at the point x = 1 and y =0. [6]

3. a) Define area coordinates and state its applications. [4]
   b) Discuss about local and global coordinate system. [5]
   c) Explain the concept of mesh generation. [5]

4. a) Drive the shape functions of beam element. [7]
   b) Derive the stiffness matrix of two node beam element. [7]

5. Determine the deflection and stresses at the point of load application on a plate, by considering two triangular elements shown in Figure 5(b). Assume thickness t = 4 mm, Poisson's ratio = 0.25 and Young's Modulus E= 210 GPa. Consider plane stress analysis.

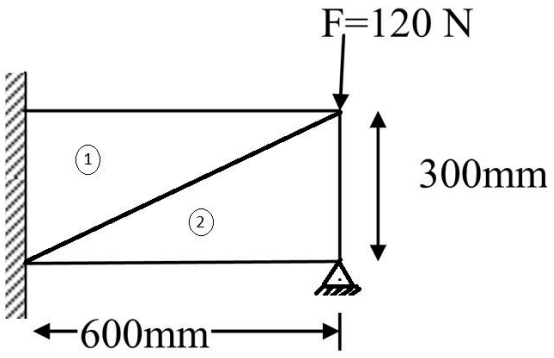
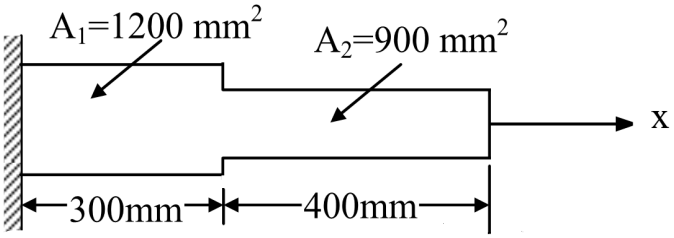


Figure 5(b) [14]

6. a) From the first principles, derive the shape functions for 2-D quadrilateral element. [7]
   b) How to solve the integration over rectangular regions in 2-Dimensional problems using Gaussian Quadrature numerical integration. [7]

7. Consider axial vibration of the steel bar shown in Figure.
   (i) Develop the global stiffness and mass matrices and
   (ii) Determine the natural frequencies and mode shapes using the characteristic polynomial technique.



Figure

[14]

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

IV B.Tech I Semester Regular Examinations, October/November - 2019

FINITE ELEMENT METHODS

(Common to Mechanical Engineering and Automobile Engineering)

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

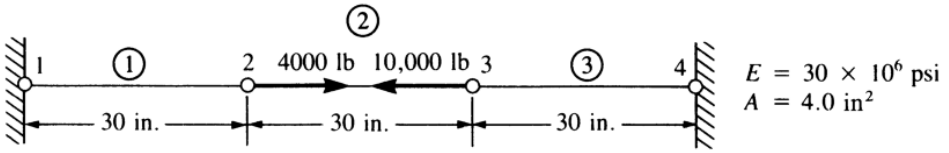
Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any FOUR questions from Part-B
*****

PART–A *(14 Marks)*

1. a) Write the D-matrix for 3-D problems. [2]
   b) Draw a local and global coordinates? What is their importance in FEM. [2]
   c) Derive the transformation matrix of a plane truss element. [3]
   d) Why a three node triangle element called as a CST element? [2]
   e) What is a sub parametric and a super parametric element? [3]
   f) Write the element stiffness matrix and lumped mass matrices of a two node bar element. [2]

PART–B *(4x14 = 56 Marks)*

2. a) Explain the variational formulation in FEM problems with help of a suitable example. [6]
   b) For the bar assemblages shown in Figure 2(b), determine the nodal displacements, the forces in each element, and the reactions.

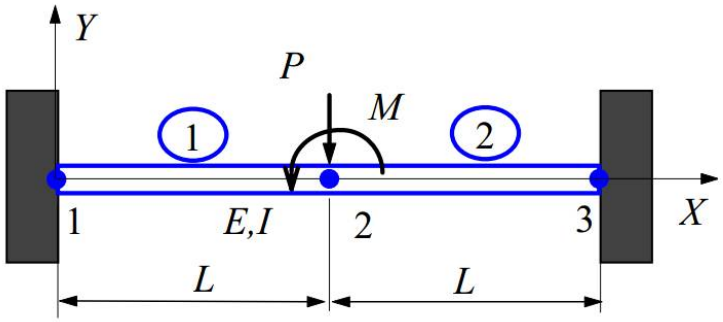


[8]

Figure.2(b)

3. a) Describe the natural coordinate system and generalized coordinate system. [7]
   b) Explain convergence and compatibility criteria. [7]

4. A beam as shown in the figure. 4(a) is clamped at the two ends and acted upon by force P and moment M in the mid-span. Find the deflection and rotation at the center node.



[14]

Figure.4(a)

|''|'||||''|''|'|'|

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

5. Derive the stiffness matrix [K] and the load vector for the two dimensional simplex element shown in Figure, also determine nodal displacements of triangular element, strain and stress of an element. Assume E = 260 MPa, μ = 0.3 and t = 10 mm.

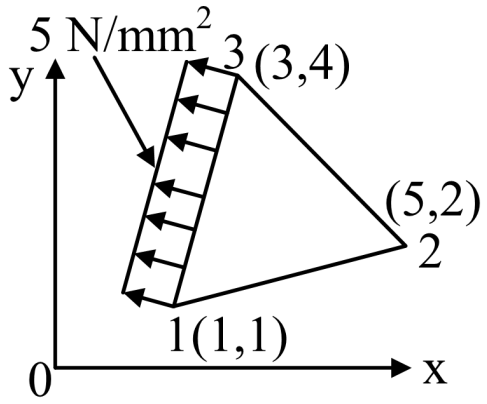


Figure [14]

6. a) Discuss in detail the concept of Isoparametric Element. [6]
   b) Using Isoparametric concept, Formulate the Element Stiffness Matrix for a uni-dimensional Two noded element with constant cross sectional area 'A' and Modulus of Elasticity "E". [8]

7. a) Discuss about lumped mass and consistent mass matrix. [5]
   b) Determine the temperature distribution in a straight fin of circular c/s. Use three one dimensional linear elements and consider the tip is insulated. Diameter of fin is 1 cm, length is 6cm, h = 0.6 W/cm^{20}C, $\varphi_\infty=25^0$C and base temperature is $\varphi_1=80^0$ C. [9]

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

IV B.Tech I Semester Regular Examinations, October/November - 2019

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 steps in the concepts of FEM formulation. [2]
   b) Sketch different elements used in FEM. [2]
   c) Write the stiffness matrix of a beam and truss elements. [2]
   d) Give examples of axisymmetric problems. [3]
   e) What is the importance of numerical integration in FEM? [2]
   f) How do you understand the Eigen vectorsin vibration problem? [3]

PART–B *(4x14 = 56 Marks)*

2. a) Differentiate between plane stress and plane strain problems with suitable examples and derive the elasticity matrix for both the conditions. [6]
   b) Find the approximate deflection of a simply supported beam of length '*L*' under a uniformly distributed load '*p*' using the Rayleigh–Ritz method. [8]

3. a) Define natural coordinate system. Establish a relationship between local or Cartesian coordinates and natural coordinates for a 2-noded bar element. [6]
   b) Explain in detail the elimination approach for the treatment of boundary condition. [8]

4. a) The truss system shown in Figure 4(a) subjected to a load P =100 KN and Q = 100 KN at Joint. Compute the deflections u and v, stress in members 1 and 2 and reaction forces at joint 2 and joint 3.

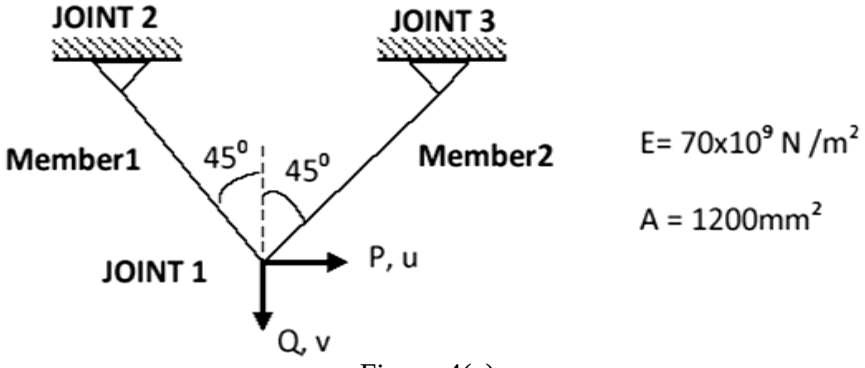


Figure 4(a)

[10]

   b) Derive the equivalent load vector of a beam element for concentrated load at the center and UDL case. [4]

5. a) Derive the strain displacement matrix of three node axisymmetric element. [9]
   b) The nodal coordinates of a triangular element are 1(1,3), 2(5,3) and 3(4,6). At a point p inside the element, the x-coordinates is 3.3 and the shape function $N_1 = 0.3$. Determine the shape functions and y-coordinates of the point P. [5]

6. a) Derive the shape functions of 4 node two dimensional isoparametric element. [7]
   b) Derive the gauss points and weights of two point gauss quadrature and evaluate the integral of $x^3 + 3x^2 - 5x - 2$ between the limits -1 and +1. [7]

7. Determine the Eigen values and Eigen vectors for the stepped bar shown in figure, $E = 30x10^6$ N/m^2, specific weight = 0.283 Kg/m^3, $A_1 = 1m^2$, $A_2 = 0.5m^2$ $L_1 = 10m$, $L_2 = 5m$.

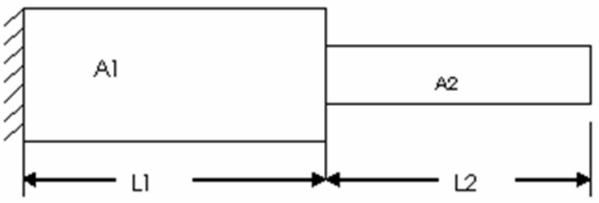


Figure [14]

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

IV B.Tech I Semester Regular Examinations, October/November - 2019

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)*

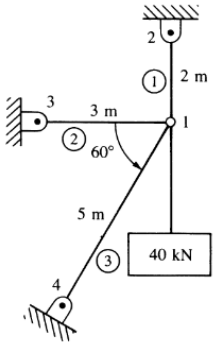
1. a) What are plane stress and plane strain conditions? [3]
   b) Write a short note on domain discretization. [2]
   c) Differentiate between truss and a beam. [2]
   d) Write the shape functions for four nodded Quadrilateral element. [2]
   e) What is numerical integration? Write its importance in FEM [2]
   f) What is a free vibration problem? What does eigen values and eigen vetcors represent in a free vibration problem. [3]

PART–B *(4x14 = 56 Marks)*

2. a) Discuss about any two weighted residual methods with the help of an example. [7]
   b) What are the major limitations of finite element method? Explain the conditions to overcome those limitations. [7]

3. a) Explain in detail the convergence and compatibility requirements. When do you call an element as a conforming and complete? [7]
   b) Explain the factors to be considered in selecting the interpolation function. [7]

4. For the plane trusses shown in Figure, determine the horizontal and vertical displacements of node 1, stresses in each element and reactions at node 3. All elements have E = 200 GPa and A = 2 X $10^{-4}m^2$



Figure

[14]

5. a) Compute the strain displacement matrix and also the strains of an axisymmetric triangular element with the coordinates r_1 = 3 cm, z_1 = 4 cm, r_2 = 6 cm, z_2 = 5 cm, r_3 = 5 cm, z_3 = 8 cm. The nodal displacement values are u_1 = 0.01 mm, w_1 = 0.01 mm, u_2 = 0.01 mm, w_2 = -0.04 mm, u_3 = -0.03 mm, w_3 = 0.07 mm. [8]
   b) Discuss about CST element and LST element. [6]

6. a) Explain in detail how the element stiffness matrix and load vector are evaluated in isoparametric formulations. [7]
   b) Explain the concept of isoparametric elements and super parametric elements. [7]

7. a) Derive element equations for a one dimensional heat conduction element using weak form formulation. [7]
   b) Discuss about consistent mass matrix and lumped mass matrix. Derive the above two matrices for a two node beam element. [7]