Code No: 09A51401 | R09 | SET-1

B. Tech III Year I Semester Examinations, December-2011
FINITE ELEMENT TECHNIQUES
(MECHANICAL ENGINEERING (MECHATRONICS)

Time: 3 hours **Max. Marks: 75**

Answer any five questions
All questions carry equal marks

1.a) What is meant by the descritization? Explain the important points to be considered during descritization.
b) What is interpolation function? Explain its importance in evaluation of the displacements values in finite element method. [7+8]

2. Calculate displacement vector, strains, stresses, strain energy and reactions for the following figure 1? Take E = 2 X 105 N/mm^2. [15]

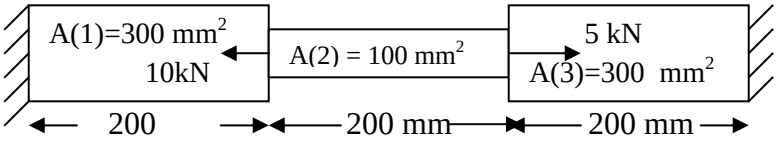

figure 1

3. Estimate the displacement vector, strains, stresses and reactions in the truss structure shown below in figure 2.Take A = 1000 mm^2 and E = 200 GPa. [15]

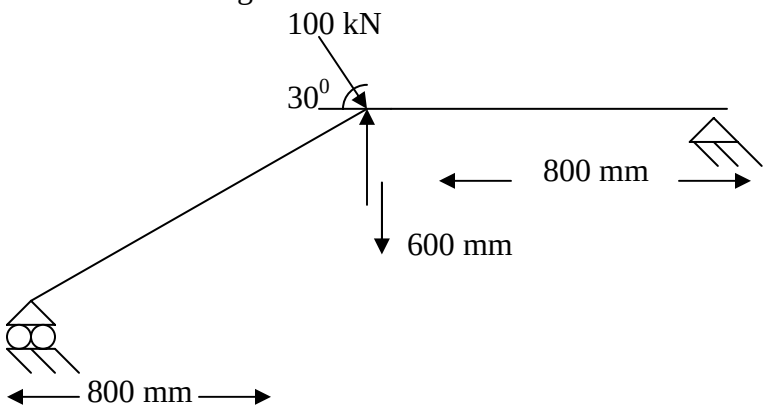

figure 2

4. A beam is fixed at one end an supported by a roller at the other end, has a 20 kN concentrated load applied at the centre of the span of 10 m. Calculate the deflection and slope and also construct the shear force and bending moment diagrams. Take I = 2500 cm^4 and E = 20 x 10^6 N/cm^2. [15]

5.a) Evaluate the load vector for the triangular element subjected to a body force and a variable traction force on the side 1-2.
b) Estimate the shape function values at the point P(x, y) in terms of x and y of a triangular element with the coordinates 1(0.0), 2(20,25) and 3(10,35). [7+8]

6.a) Derive the shape functions of four nodded quadrilateral element.

b) Differentiate between Axi symmetric elements and symmetric elements with suitable examples. [7+8]

7.a) Derive the conductivity matrix for 3 noded triangular element with convection boundary condition at one of the faces of the element.

b) Estimate the temperature profile in a pin fin of diameter 30 mm, whose length is 750 mm. The thermal conductivity of the fin material is 50 W/m K and heat transfer coefficient over the surface of the fin is 40 W/m^2 K at 30^0C. The tip is also exposed to convection and the base temperature of the fin is 800^0C. [7+8]

8. Determine the Eigen values and Eigen vectors for the stepped bar shown in figure 3. $E=30x10^6$ N/m^2 ,specific weight = 0.283 Kg/m^3 A_1= 1 m^2 A_2= 0.5 m^2 L_1=10 m. L_2 =5 m. [15]

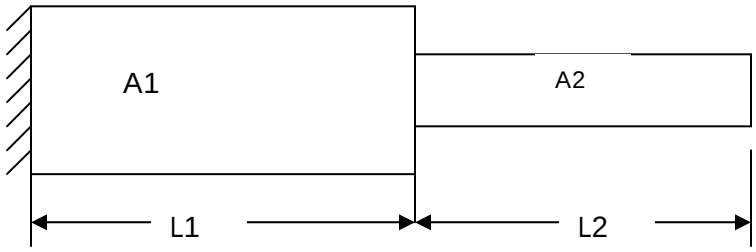

figure 3

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B. Tech III Year I Semester Examinations, December-2011
FINITE ELEMENT TECHNIQUES
(MECHANICAL ENGINEERING (MECHATRONICS)

Time: 3 hours **Max. Marks: 75**

Answer any five questions
All questions carry equal marks

1.a) Derive the stress strain relation matrix for solving 3-D problems based on Generalised Hooke's law.

b) What do you understand from the terms boundary conditions and initial conditions? Explain them. [7+8]

2. A stepped bar is subjected to an axial load of 300 kN as shown in figure 1. Find the nodal displacements, element stresses and strains and reactions. Take E = 2 X 10^5 N/mm^2. The lengths of the bars are 300 mm and the load is acting at the centre from the one end of the bar. [15]

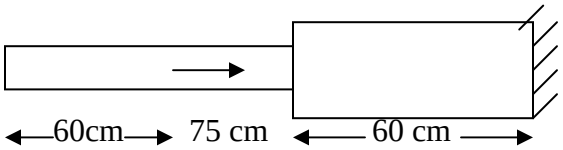

figure 1

3.a) The coordinates of the plane truss element is given as 1(10,30) and 2(25,40) mm has the displacement values $\{0.1\ 0.2\ 0.1\ -0.3\}^T$ with the material properties 200 GPa Youngs Modulus. Calculate the stiffness matrix, load vector and strain energy if the cross sectional area of the truss is 100 mm^2.

b) Derive the stiffness matrix for the space truss element. [7+8]

4. Calculate the maximum deflection and slope by using finite element method for the simply supported beam of length L, Young's modulus E and the moment of Inertia I, subjected to a point load of P at the centre. Compare the results with theoretical equations. [15]

5.a) For the point P located inside the triangular element with the coordinates 1(2,1), 2(4,2) and 3(3,5) if the shape functions N_1 and N_2 are 0.3 and 0.5. Find the coordinates of x and y at that point P.

b) Calculate the equivalent point loads for the triangular element subjected to a variable pressure on the side 2-3. [7+8]

6.a) Derive the Jacobian matrix for the 2-D quadrilateral element in terms of natural coordinates.

b) Derive the strain displacement relation matrix for axi-symmetric triangular element using Galerkin method. [7+8]

7. Calculate the temperature values at the junction points of the composite slab made of two different materials with 25 W/m K of 0.25 m thick and 40 W/m K of 0.2 5m thick. The inner wall is exposed to a convective heat transfer coefficient of 50 W/m^2K, 50^0C and other wall is exposed to a heat flux of 50 kW/m^2. There is an internal heat generation of 500 kW/m^3 in the second layer of the composite slab. [15]

8. Find the natural frequencies of longitudinal vibration for a constrained and unconstrained stepped bar as shown in the fig 2. Where A = area of cross section. [15]

E = young's modulus ρ = density.

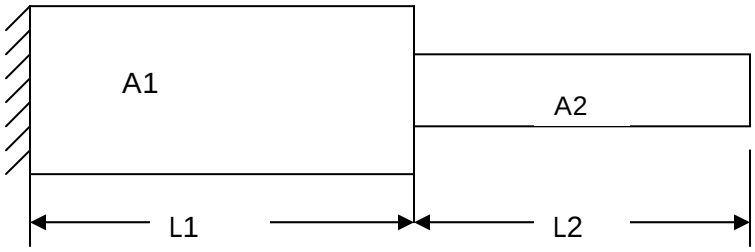

figure 2

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B. Tech III Year I Semester Examinations, December-2011
FINITE ELEMENT TECHNIQUES
(MECHANICAL ENGINEERING (MECHATRONICS)

Time: 3 hours **Max. Marks: 75**

Answer any five questions
All questions carry equal marks

1.a) Why polynomial type of interpolation function is preferred over trigonometric functions? Explain.

b) Explain the steps involved in obtaining an approximate solution using finite element method. [7+8]

2. Estimate the displacements, forces and stresses in the bar loaded shown in figure. The stiffness values of the bars are also shown in figure 1. [15]

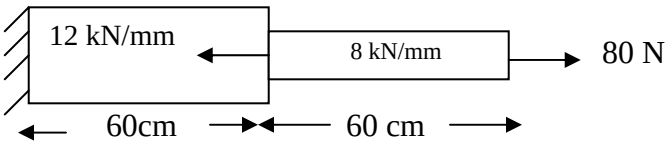
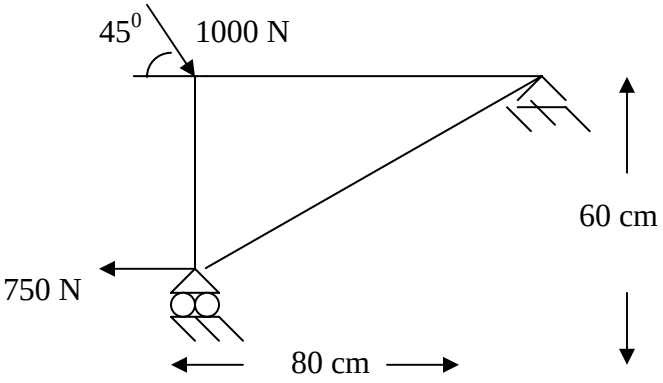


figure 1

3. Estimate the displacement vector, strains, stresses and reactions in the truss structure below in figure 2. [15]



A = 1000 mm^2
E = 2 X 10^6 N/mm^2

figure 2

4. Calculate the deflection at the center and slopes at the ends of a simply supported beam of 2 m length subjected to a UDL of 50 kN/m throughout the length, a bending moment of 50 kN-m and a point load of -500kN at the centre and also calculate displacement at a distance 1.5 m from one end. Take EI = 700 N-mm^2. [15]

5.a) Derive the shape functions for the triangular element for the two dimensional structural problems.

b) Compute the strain displacement relation matrix and stiffness matrix of a triangular element with the co ordinates 1(3,4), 2(6,5) and 3(5,8) for the plane stress conditions. Take E=200 GPa, poison's ratio = 0.3 and thickness 1 mm. All dimensions are in mm. [7+8]

6.a) Explain the Gaussian Quadrature method for solving the numerical integration problems of two dimensional in nature.

b) What is axi symmetric element? And discuss its importance in solving the axi symmetric problems. [7+8]

7. Consider a brick wall of thickness 0.3 m, k=0.7 W/m K . The inner surface is at 28^0C and the outer surface is exposed to cold air at -15^0C . The heat transfer coefficient associated with the outside surface is 40W/m^2 K. Determine the steady state temperature distribution with in the wall and also the heat flux through the wall. Use two elements and obtain the solution. [15]

8. Estimate the displacement values and draw the mode shapes for the bar shown in figure 3. The load acting at the end of the bar is 75 kN. [15]

Take E = 2 E 5 N/mm^2 ; density = 1000 kg/m^3

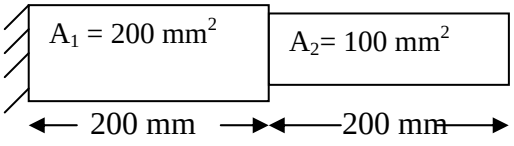


figure 3

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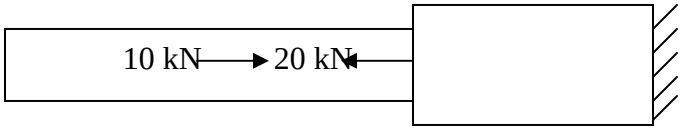
B. Tech III Year I Semester Examinations, December-2011
FINITE ELEMENT TECHNIQUES
(MECHANICAL ENGINEERING (MECHATRONICS)

Time: 3 hours **Max. Marks: 75**

Answer any five questions
All questions carry equal marks

1.a) What are different applications of finite element method? Discuss with examples.
b) What is interpolation function? Write generalized interpolation function? Discuss the importance of Pascal triangle and Pascal Tetrahedron in choosing interpolation function? [7+8]

2. For a stepped bar loaded as shown in figure 1. Determine
(i) nodal displacements (ii) support reactions and (iii) element stresses.
The areas are 15 cm^2 and 24 cm^2 and E = 200 Gpa. [15]



50cm 25 cm 60 cm
figure 1

3.a) Derive the stiffness matrix for plane truss element from first principles.
b) The coordinates of the plane truss element is given as 1(10, 30) and 2(25, 40) mm has the displacement values $\{0.1\ 0.2\ 0.1\ -0.3\}^T$ with the material properties 200 GPa Youngs Modulus. Calculate the stiffness matrix, load vector and strain energy if the cross sectional area of the truss is 100 mm^2. [7+8]

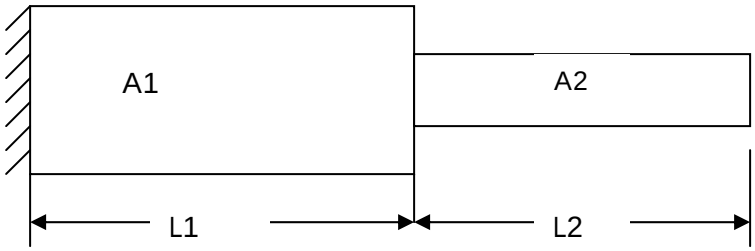
4. Why the Hermite shape functions are considered for the beam element? Explain the Hermite shape functions for a two nodded beam element. And also derive the strain displacement relation matrix. [15]

5.a) Discuss the importance of iso parametric conditions in solving the CST problems.
b) Calculate the load vector for a triangular element shown in above figure subjected a variable traction load on the face 1-2 of 5 MPa and on the face 2-3 a variable load of 2MPa to 4 MPa. A point load of 400 kN acts at the node 3 with the inclination of 30^0 with horizontal axis. [7+8]

6.a) Derive the one point formula of numerical integration over the given limits using Gaussian quadrature method.
b) Describe the method to solve 1-D axi-symmetric problems using Galerkin approach. [7+8]

7. A large industrial furnace is supported on a long column of fire clay brick, which is 1 X 1 m on a side .During steady state operation, installation is such that three surfaces of the column are maintained at 600 K, while the remaining surface is exposed to an air stream for which T_α = 300 K and h = 12 W/m^2k. Determine the temperature distribution in the column and the heat rate to the air stream per unit length of column. Take K= 1 W/mK. [15]

8. Determine the natural frequencies and corresponding mode shapes for the fig. shown below. ρ = 7850 kg/m^3, E = 2 x 10^{11} N/m^2 [15]



L_1=1m, L_2=2m, A_1=$2m^2$, A_2=$1m^2$

figure 2

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