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ME8692 FINITE ELEMENT ANALYSIS

IMPORTANT QUESTIONS AND QUESTION BANK

UNIT I: INTRODUCTION

2-Marks

1. Write the stiffness matrix for a one dimensional 2 noded linear element?
2. Point out any four advantages of finite element method?
3. State the advantages of Rayleigh Ritz method?
4. Compare the Ritz technique with the nodal approximation method?
5. How to develop the equilibrium equation for a finite element?
6. List the various method of solving boundary value problems?
7. How will you identify types of Eigen Value Problems?
8. Mention the weak formulation of FEA?
9. Discuss Ritz method?
10. State the principle of minimum potential energy?

Part-B

1. Describe the step by step procedure of solving FEA?
2. The Governing Equation for one dimensional heat transfer through a fin of length *l* attached to a hot source as shown in fig is given by if the free end of the fin in insulated give the boundary conditions and determine using the Collocation technique the temperature distribution in the fin. Report the temperature at the free end?
3. The following differential equation is available for a physical phenomenon, $d^2y/dx^2 – 10x^2 = 5$, $0 \le x \le 1$ with boundary conditions as y (0) = 0 and y (1) = 0. Find an approximate solution of the above differential equation by using Galerkin's method of weighted residuals and also compare with exact solution.?
4. Solve the ordinary differential equation $d^2y/dx^2 + 10\ x^2 = 0$, $0 \le x \le 1$ with boundary conditions as y (0) = 0 and y (1) = 0 using the Galerkin's method with the trial function No(x) = 0; N1(x) = $x\ (1-x^2)$.
5. Solve the differential equation for a physical problem expressed as $d^2y/dx^2 + 50 = 0$, $0 \le x \le 10$ with boundary conditions as y (0) = 0 and y (10) = 0 using the trial function $y = a_1x\ (10-x)$ find the value of the parameters a1 by the following methods listed below.
   (i) Point collocation method (ii) Sub domain collocation method (iii) Least squares method and (iv) Galerkin method
6. A beam AB of span 'l' simply supported at the ends and carrying a concentrated load 'W' at the centre 'C' as shown in figure .Determine the

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deflection at the mid span by using Rayleigh-Ritz method and compare with exact solution/

7. Determine the expression for deflection and bending moment in a simply supported beam subjected to uniformly distributed load over entire span. Find the compare with exact solution Rayleigh-Ritz

$$y = a_1 \sin\left(\frac{\pi x}{l}\right) + a_2 \sin\left(\frac{3\pi x}{l}\right)$$

8. Calculate the value of central deflection in the figure below by assuming Y = a sin πx/L the beam is uniform throughout and carries and central point load P.
9. Explain the various methods of engineering analysis with suitable illustrations?
10. Describe the principle of stationary total potential energy?
11. Explain the details about the List the various weighted residual methods?
12. Write a short notes on error and residual?
13. Explain the details about Ritz method?
14. A uniform rod subjected to a uniform axial load is illustrated in figure, the deformation of the bar is governed by the differential equation given below. Determine the displacement by applying Weighted Residual Method (WRM)

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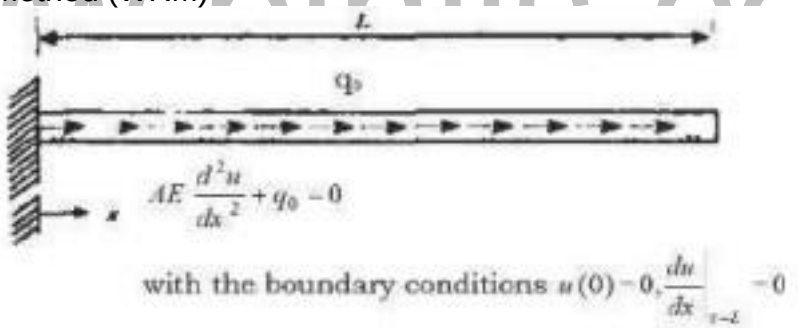


UNIT 2 ONE-DIMENSIONAL PROBLEMS

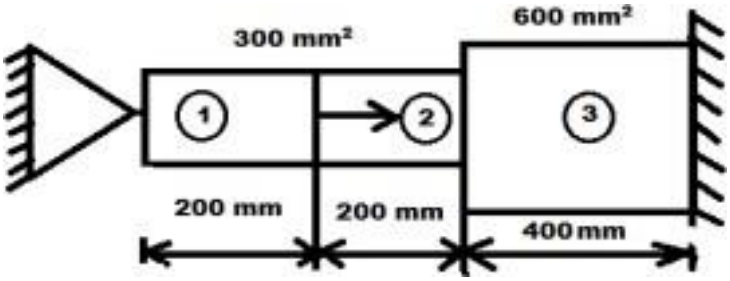
2-Marks

1. Define shape function?
2. Illustrate shape function of a two node line element?
3. Differentiate global and local coordinate?
4. Express the element stiffness matrix of a truss element?
5. Define natural coordinate system?
6. Give the shape function equation for a 1D quadratic bar element?
7. Define mode superposition technique?
8. Express the mass matrix for a 1D linear bar element?

9. Illustrate the expression of longitudinal vibration of the bar element?
10. Define the transverse vibration?

Part-B

1. Formulate the shape function for One-Dimensional Quadratic bar element.?
2. For the bar element as shown in the figure. Calculate the nodal displacements and elemental stresses. Take E= 2.1 x 10^5 N/mm^2.



3. A steel bar of length 800mm is subjected to an axial load of 3kN as shown in fig. Estimate the nodal displacement of the bar and load vectors. Take E= 2 x 10^5 N/mm^2

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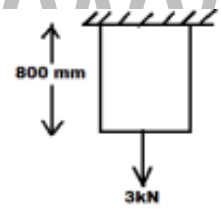
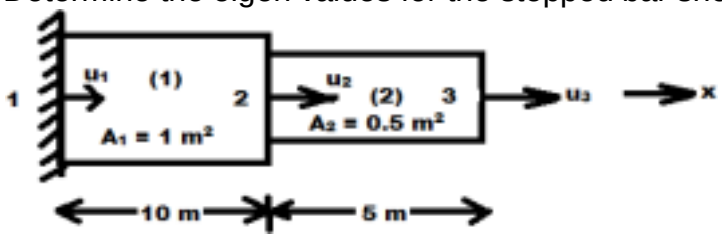
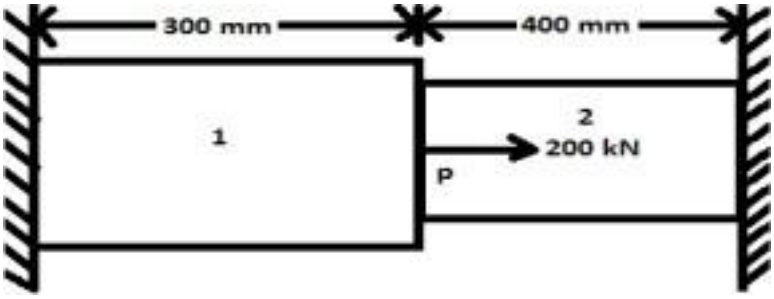


4. Determine the eigen values for the stepped bar shown in figure?

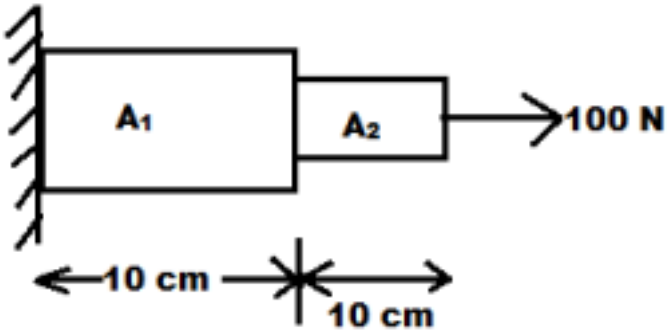


5. Consider a bar as shown in figure an axial load of 200kN is applied atpoint P. Take A_1=2400 mm^2, E_1=70x10^9 N/mm^2 A_2=600 $mm^2$and E_2 = 200x10^9 N/mm^2. Calculate the following (i) the nodal displacement

at point,P (ii) Stress in each element (iii) Reaction force

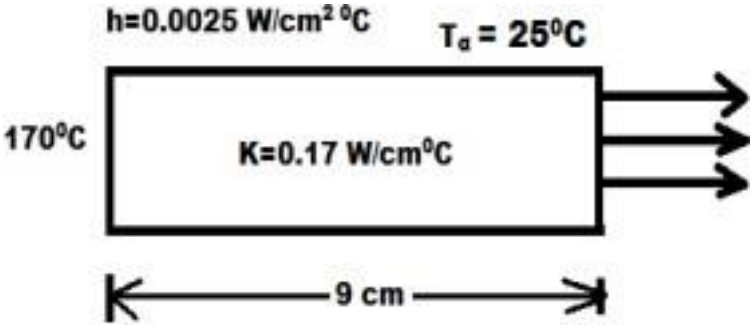


6. For a tapered bar of uniform thickness t=10mm as shown in figure Predict the displacements at the nodes by forming into two element model. The bar has a mass density ρ = 7800 kg/m^3, the young's modulus E = 2x10^5 MN/m^2. In addition to self-weight, the bar is subjected to a point load P= 1 kN at its Centre. Also determine the reaction forces at the support?
7. Consider a bar as shown in fig Young's Modulus E=2 x 10^5 N/mm^2 A_1= 2 cm^2; A_2 = 1cm^{2}and force of 100N. Calculate the nodal



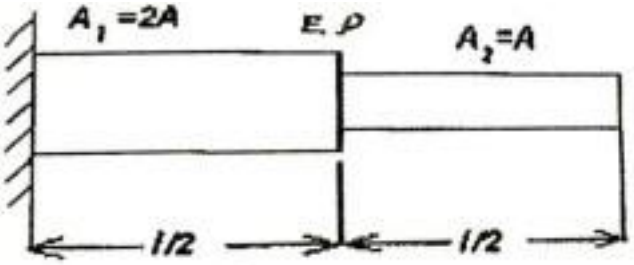
displacement

8. A metallic fin 20 mm wide and 4 mm thick is attached to a furnace whose wall temperature is 180 °C. The length of the fin is 120 mm. if the thermal conductivity of the material of the fin is 350 W/m °C and convection coefficient is 9 W/m^2°C, determine the temperature distribution assuming that the tip of the fin is open to the atmosphere and that the ambient temperature is 25 °C
9. Calculate the temperature distribution in the stainless steel fin shown in the figure. The region can be discretized in three elements of equal

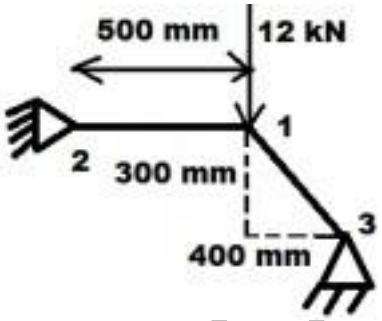


sizes

10. Determine the first two natural frequencies of longitudinal vibration of the stepped steel bar shown in fig. and plot the mode shapes. all the dimensions are in mm E=200GPa. and ρ= 0.78 kg/cc. A=4 cm^2, length *l*=500mm?



11. For the twobar truss shown in the fig, Estimate the displacements of node 1 and the stress in element 1-3Take E=70GPa A=200 mm^2



12. Determine the deflection in the beam loaded as shown in fig. at the mid span and at the length of 0.5m from the left support. Determine also the reactions at the fixed ends. E= 200 GPa. I_1= 20 x 10^{-6} m^4 I_2 = 10 x 10^{-6} m^4
13. Develop the Shape function, Stiffness matrix and force vector for one dimensional linear element?
14. Explain the details about the elements types linear and higher order elements?

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UNIT 3 TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS

2-Marks

1. Show the displacement function equation for CST element?
2. How will you modify a three-dimensional problem to a Two dimensional problem?
3. What is meant by steady state heat transfer? Write down its governing differential equation?
4. Define two-dimensional scalar variable problem?
5. How do you define two dimensional elements?
6. Define QST (Quadratic strain Triangle) element.
7. Relate path line with streamline?
8. Formulate the (B) matrix for CST element?

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9. List out the CST and LST elements?
10. Write down the shape functions for a 4 noded quadrilateral element?

Part-B

1. Derive the conductance matrix for a 3 noded triangular element whose nodal coordinates are known. The element is to be used for two dimensional heat transfer in a plate fin?
2. Determine the shape functions for a constant strain triangular (CST) element?
3. Compute the element matrices and vectors for the element shown in fig. when the edges 2-3 and 1-3 experience convection heat loss?
4. Find the temperature distribution in a square region with uniform energy generation as shown in fig. assume that there is no temperature variation in the Z-direction. Take k=300W/cm°C, L=10cm, T_∞ =50°C and q=100 W/cm
5. Derive the expression for shape function for heat transfer in 2D element?
6. Develop the shape function derivation for a two-dimensional quadratic element?
7. Estimate the stiffness matrix for the triangular element with the (x,y) coordinates of the nodes are (0,-4), (8,0) and (0,4) at nodes i, j, k. Assume plane stress condition E= 200 GPa, Poisson's ratio = 0.35?
8. The x,y coordinates of nodes i,j and k of a triangular element are given by (0,0) (3,0) and (1.5,4) mm respectively. Evaluate the shape functions N1 and N2 and N3 at an interior point (2,2.5) mm of the element evaluate the strain displacement relation matrix B for the above same triangular element and explain how stiffness matrix is obtained assuming scalar problem?
9. Calculate the value of pressure at the point A which is inside the 3 noded triangular element as shown in fig. The nodal values are Φ_1 = 40 MPa, Φ_2 = 34 MPa and Φ_3 = 46 MPa. point A is located at (2, 1.5). Assume the pressure is linearly varying in the element. Also determine the location of 42 MPa contour line?
10. For a 4-noded rectangular element shown in fig. Infer the temperature at the point (2.5, 2.5). The nodal values of the temperatures are T_1= 100°C, T_2= 60°C and T_3= 50°C and T_4= 90°C. Also determine the 80°C isotherm?
11. Calculate the element stiffness matrix and temperature force vector for the plane stress element shown in fig. The element experiences a 20ºC increase in temperature. Assume $\alpha = 6x10^{-6}$ C. Take $E=2x10^5$ N/mm^2, v= 0.25, t= 5mm

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12. Develop the shape function derivation for a one-dimensional quadratic element?
13. Estimate the stiffness matrix for the triangular element with the (x,y) coordinates of the nodes are (0,-4), (8,0) and (0,4) at nodes i, j, k. Assume plane stress condition E= 200 GPa, Poisson's ratio = 0.35

UNIT 4 TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS

2-Marks

1. Classify the types of shell element?
2. List out the various elasticity equations?
3. Define plane stress and plane strain?
4. Discuss 'Principal stresses"?
5. Write the strain displacement matrix for a 3 noded triangular element.?
6. Distinguish between plate and shell elements?
7. Define axisymmetric formulation?
8. Develop the Shape functions for axisymmetric triangular elements?
9. Show the Stress-Strain displacement matrix for axisymmetric solid?
10. Define a plane stress problem with a suitable example?

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Part-B

1. Develop shape function for axisymmetric triangular elements?
2. Calculate the element stiffness matrix for the axisymmetric triangular element shown in fig. The element experiences a 15ºC increase in temperature. The coordinate are in mm. Take $\alpha=10x10^{-6}/ºC$, $E=2x10^5$ N/mm^2, v=0.25?
3. Explain the classification of shell elements and also brief the assumption used in finite elements analysis of shell elements?
4. A tin plate of thickness 5mm is subjected to an axial loading as shown in the fig. It is divided into two triangular elements by dividing diagonally. Determine the Strain displacement matrix [B], load vector and the constitutive matrix. How will you derive the stiffness matrix? (Need not be determined). What will be the size of the assembled stiffness matrix? What are the boundary conditions? E=2x107 N/cm2 μ=0.3?
5. Evaluate the Stress-Strain relationship matrix for axisymmetric triangular element?
6. Develop Strain-Displacement matrix for axisymmetric triangular element?

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7. Derive the Finite element equation for triangular plate bending element with 9 degrees of freedom?
8. Develop the four basic sets of elasticity equation?
9. Evaluate the stiffness matrix. Take modulus of elasticity E = 210 GPa. Poisson's ratio = 0.25. the coordinates are given in millimeters ?
10. Triangular element are used for the stress analysis of plate subjected to in plane loads. The (x,y) coordinates of nodes 1, 2, and 3 of an element are given by (5,5), (25,5), and (15,15) mm respectively. The nodal displacement are given as: u1=0.005 mm, u2=0.002 mm, u3= 0.0 mm, u4=0.0 mm, u5= 0.005 mm, u6= 0.0 mm. Evaluate element stress. LetE= 200 GPa, poisson's ratio = 0.3 and use unit thickness of the element
11. A long hollow cylinder of inside diameter 100mm and outside diameter 120mm is firmly fitted in a hole of another rigid cylinder over its full length as shown in fig. The cylinder is then subjected to an internal pressure of 2 MPa. By using two element on the 10mm length shown calculate the displacements at the inner radius tame E = 210 GPa. μ = 0.3
12. The nodal coordinates for an axisymmetric triangular element . Evaluate the strain-displacement matrix
13. state whether plane stress or plane strain elements can be used to model the following structures. Explain your answer A wall subjected to wind load

    A wrench subjected to a force in the plane of the wrench
14. Derive the Finite element equation for triangular plate bending element with 9 degrees of freedom?

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UNIT 5 ISOPARAMETRIC FORMULATION

2- Marks

1. Illustrate the purpose of Iso parametric element?
2. Define Iso parametric formulation?
3. Explain the Jacobian transformation?
4. Give the shape functions for a four- node linear quadrilateral element in natural coordinates?
5. List out the advantages of Gauss quadrature numerical integration for Iso parametric element?
6. Define Iso parametric element?
7. Discuss about Numerical integration?
8. Discuss about Gauss-quadrature method?
9. Differentiate between geometric and material non-linearity.
10. Distinguish between trapezoidal rule and Gauss quadrature?

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Part-B

1. Develop the shape function for 4 node Iso parametric quadrilateral element?
2. Develop the strain displacement matrix, stress-strain matrix and stiffness matrix for an Iso parametric quadrilateral element?
3. Consider the Iso parametric quadrilateral element with nodes 1 to 4 at (5,5), (11,7) (12,15), and (4,10) respectively. Estimate the jacobian matrix and determinant at the element centroid
4. Tabulate the element characteristics of a fournode quadrilateral element?
5. Write a short notes on (a) Jacobian matrix (b)Strain-Displacement matrix (c) Element strain and (d) Element stress
6. Evaluate the Jacobian matrix at the local coordinates ε=η= 0.5 for the linear quadrilateral element with its global coordinates

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7. Develop the shape function for 3 node Iso parametric quadrilateral elements?
8. Develop Stiffness matrix for Iso parametric quadrilateral element?
9. State the transformation for mapping x-coordinate system into a natural element co-ordinate system for a linear spar element and for a quadratic spar?
10. Distinguish between trapezoidal rule and Gauss quadrature rule and Simpson's rule?
11. Explain the details of plane stress and plane strain?
12. Write a note on body forces and temperature effects?

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