UNIT I INTRODUCTION

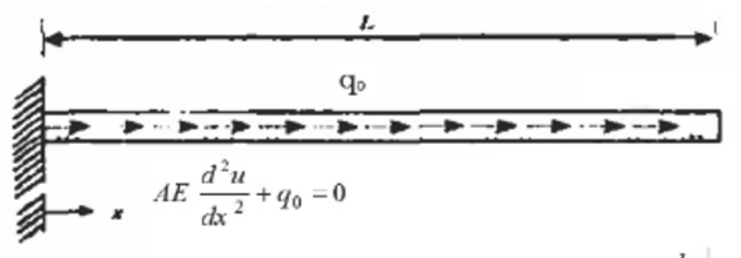
PART-A

1. Distinguish between Error and Residual.
2. Discuss the finite element method work.
3. List any four advantages of finite element method.
4. List out the types of nodes.
5. List any four advantages of weak formulation?
6. Compare the Ritz technique with the nodal approximation method.
7. How to develop the equilibrium equation for a finite element?
8. Classify boundary conditions
9. List the various method of solving boundary value problems.
10. Formulate the boundary conditions of a cantilever beam AB of span L fixed at A and free at B subjected to a uniformly distributed load of P throughout the span.
11. Name the weighted residual methods.
12. How will you identify types of Eigen Value Problems?
13. Explain weak formulation of FEA
14. Why are polynomial types of interpolation function recommended over trigonometric function?
15. What should be considered during piecewise trial function?
16. How will you develop total potential energy of a structural system?
17. Explain the principle of minimum potential energy.
18. Differentiate between initial value problem and boundary value problem?
19. List out the advantages of finite element method over other numerical analysis method.
20. Define node or joint.

PART-B

1. Explain the step by step procedure of FEA.
2. Explain the process of discretization of a structure in finite element method in detail, with suitable illustration for each aspect being and discussed.

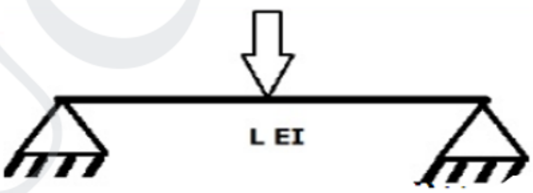
3. A uniform rod subjected to a uniform axial load is illustrated in figure, the deformation of the bar is governed by the differential equation given below. Determine the displacement by applying Weighted Residual Method (WRM)



with the boundary conditions $u(0) = 0, \left.\frac{du}{dx}\right|_{x=L} = 0$

4. Find the approximate deflection of a simply supported beam under a uniformly distributed load 'P' throughout its span. By applying Galerking and Least Square Residual Method
5. Solve the differential equation for a physical problem expressed as $d^2y/dx^2 + 100 = 0$, $0 \leq x \leq 10$ with boundary conditions as $y(0)=0$ and $y(10)=0$ using (i) Point collocation method (ii) Sub domain collocation method (iii) Least square method and (iv) Galerkin method
6. Develop the characteristic equations for the one dimensional bar element by using piece-wise defined interpolations and weak form of the weighted residual method?

7. A simple supported beam subjected to uniformly distributed load over entire span and it is subjected to a point load at the centre of the span. Calculate the deflection uing Rayleigh-Ritz method and compare with exact solutions.
8. Calculate the value of central deflection in the figure below by assuming $Y = a \sin \pi x/L$ the beam is uniform throughout and carries and central point load P.



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

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

10. A simply supported beam carries uniformly distributed load over the entire span. Calculate the bending moment and deflection. Assume EI is constant and compare the results with other solution.

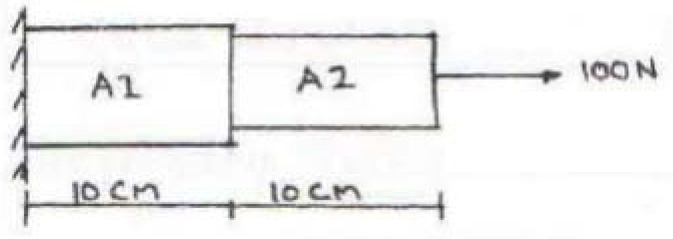
UNIT II ONE-DIMENSIONAL PROBLEMS

PART-A

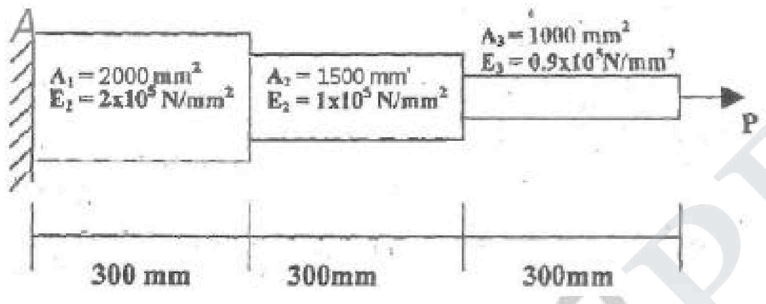
1. What are the types of problems consider as one dimensional problem?
2. Define shape function.
3. illustrate shape function of a two node line element
4. List out the stiffness matrix properties.
5. Describe the characteristics of shape functions
6. Differential global and local coordinate.
7. Express the element stiffness matrix of a truss element
8. illustrate a typical truss element shown local global transformation
9. Define natural coordinate system
10. List the types of dynamic analysis problems
11. Define Lumped mass matrix?
12. Define mode superposition technique?
13. Formulate the lumped mass matrix for the truss element.
14. Assess the accuracy of the values of natural frequencies obtained by using lumped mass matrices and consistent mass matrices.
15. Determine the element mass matrix for one-dimensional dynamic structural analysis problems. Assume the two-node, linear element.
16. Write down the Governing equation and for 1D longitudinal vibration of a bar fixed at one end and create the boundary conditions
17. Explain the transverse vibration?
18. Compare primary nodes and secondary nodes?
19. Show that the global stiffness matrix is differed from element stiffness matrix?
20. Classify some of the structural problems.

PART-B

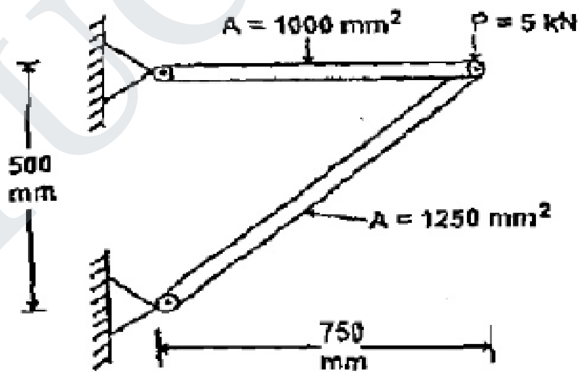
1. Develop the Shape function, Stiffness matrix and force vector for one dimensional linear element.
2. Consider a bar as shown in fig. Young's Modulus E= 2 x 10^5 N/mm^2. A_1 = 2cm^2, A_2 = 1cm^2 and force of 100N. Calculate the nodal displacement



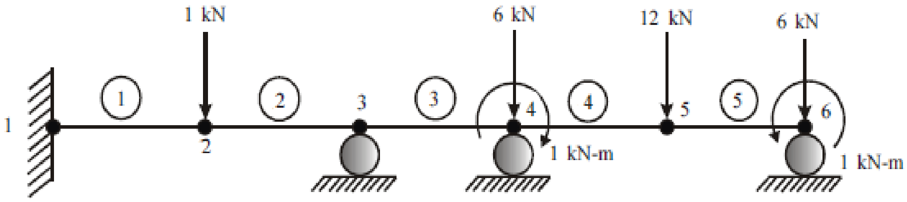
3. Consider the bar shown in figure axial force P = 30KN is applied as shown. Determine the nodal displacement, stresses in each element and reaction forces.



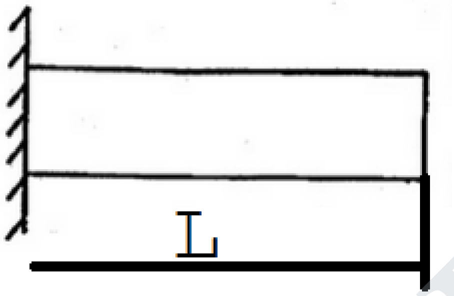
4. Axial load of 500N is applied to a stepped shaft, at the interface of two bars. The ends are fixed. Calculate the nodal displacement and stress when the element is subjected to all in temperature of 100°C. Take E_1 = 30 x10^3 N/mm^2&E_2 = 200 x 10^3 N/mm^2, A_1=900 mm^2 & A_2 = 1200mm^2, α_1 = 23x10-6 /°C & α_2 = 11.7x10-6/°C, L_1=200mm & L_2 =300mm.
5. The loading and other parameters for a two bar truss element is shown in figure. Calculate (i) The element stiffness matrix for each element (ii) Global stiffness matrix (iii) Nodal displacements (iv) Reaction force (v) The stresses induced in the elements. Assume E=200GPa.



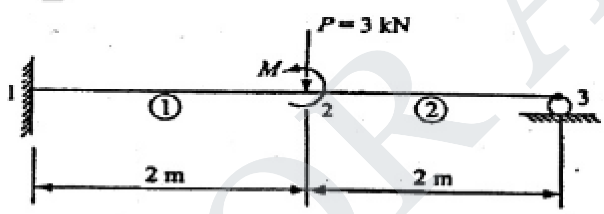
6. Figure shown a typical continuous beam. We wish to obtain the deflection of the beam using the beam element just described. For simplicity we assume EI=1



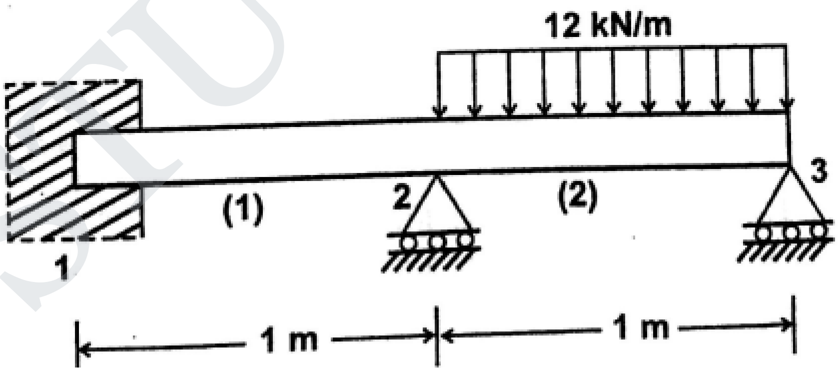
7. Find the natural frequencies of transverse vibrations of the cantilever beam shown in figure by applying one 1D beam element



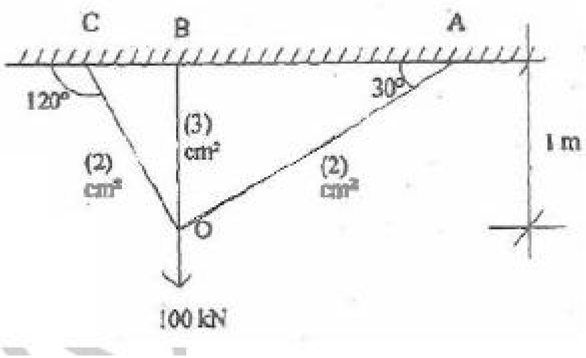
8. Calculate the displacements and slopes at the nodes for the beam shown in figure. Find the moment at the midpoint of element 1



9. For the beam and loading as shown in figure. Calculate the slopes at nodes 2 and 3 and the vertical deflection at the mid-point of the distributed load. Take E=200 GPa and $I=4x10^{-6}$ m^4 (



10. Calculate the force in the members of the truss as shown in fig. Take E=200 GPa.


C
B
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30°
(3)
cm²
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cm²
(2)
cm²
1 m
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UNIT III TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS

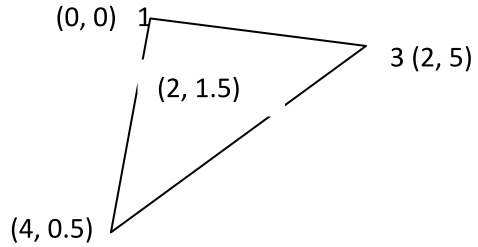
PART-A

1. Define two-dimensional scalar variable problem.
2. How will you modify a three-dimensional problem to a Tow-dimensional problem?
3. List out the application of two-dimensional problems.
4. Express the shape functions associated with the tree noded linear triangular element and plot the variation of the same.
5. Why a CST element so called?
6. How do you define two dimensional elements?
7. Explain QST (Quadratic strain Triangle) element?
8. With suitable examples and the governing equation distinguish between vector and scalar variable problems.
9. Formulate the (B) matrix for CST element.
10. Express the interpolation function of a field variable for three-node triangular element
11. List out the CST and LST elements.
12. illustrate the shape function of a CST element.
13. Define LST element.
14. Express the nodal displacement equation for a two dimensional triangular elasticity element
15. Show the transformation for mapping x-coordinate system into a natural coordinate system for a linear spar element and for a quadratic spar element.
16. What do you understand by area coordinates?
17. Define Isoperimetric elements with suitable examples
18. Explain shape function of four node quadrilateral elements.
19. Explain geometric Isotropy.
20. Write the Lagrange shape functions for a 1D, 2noded elements.

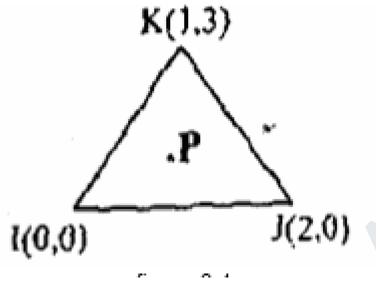
PART-B

1. Develop the element strain displacement matrix and element stiffness matrix of a CST element
2. Determine the shape functions for a constant strain triangular (CST) element.
3. The (x, y) coordinate of nodes i, j, and k of triangular elements are given by (0, 0), (3, 0) and (1.5, 4) mm respectively. Evaluate the shape functions N_1, N_2 and N_3 at an interior point P (2, 2.5) mm for the element. For the same triangular element, obtain the strain-displacement relation matrix B.
4. 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

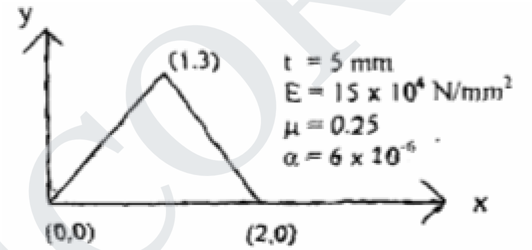
Φ_3 = 46 MPa. point A is located at (2, 1.5). Assume the pressure is linearly varying in the element. Also determine the location of 42 MPa contour line.



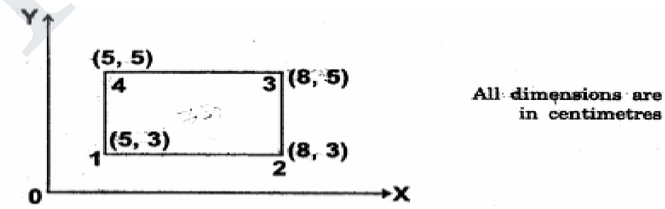
5. Find the temperature at point (1, 1.5) inside a triangular element shown with nodal temperature given as T_i = 40°C, T_j = 34°C and T_k = 46°C. Also Calculate the location of the 42°C contour line for triangular element shown in fig.



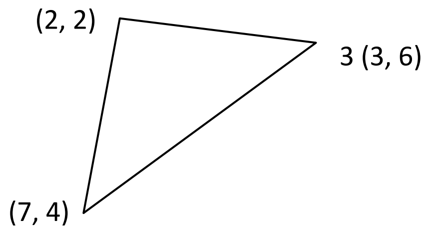
6. Calculate the element stiffness matrix and thermal force vector for the plane stress element shown in fig. The element experiences a rise of 10°C



7. For a 4-noded rectangular element shown in fig. Calculate the temperature point (7, 4). The nodal values of the temperatures are T_1 = 42°C, T_2 = 54°C and T_3 = 56°C and T4 = 46°C. Also determine 3 point on the 50°C contour line.



8. A 3 noded triangular element as shown in fig Calculate the temperature at the point P (4, 3), given that the temperatures at nodes 1, 2 and 3 are 75˚C, 90˚C and 60˚C respectively.



9. Develop the shape function derivation for a two-dimensional quadratic element.

10. Evaluate the partial derivatives of the shape function at $\zeta = 1/2$, $\eta = ½$ of a quadrilateral element, assuming that the temperature is approximated by bilinear.

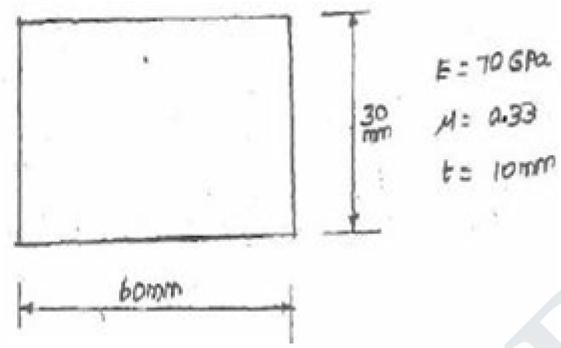
UNIT IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS

PART-A

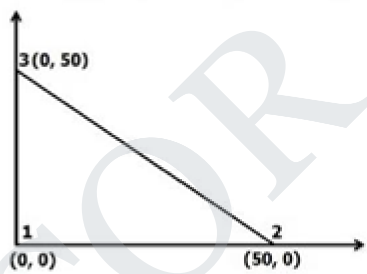
1. Define 2D vector variable problems?
2. What problems are considered as 2D vector variable problems?
3. List out the various elasticity equations.
4. Define plane stress and plane strain.
5. Discuss ‘Principal stresses”.
6. Discuss the difference between the use of linear triangular elements and bilinear rectangular elements for a 2D domain.
7. Define axisymmetric solid?
8. Distinguish between plane stress, plane strain and axisymmetric analysis in solid mechanics.
9. Specify the machine component related with axisymmetric concept.
10. Discuss axisymmetric formulation.
11. Develop the Shape functions for axisymmetric triangular elements
12. Explain about finite element modeling for axisymmetric solid.
13. Develop the Strain-Displacement matrix for axisymmetric solid
14. Write down Stress-Strain displacement matrix for axisymmetric solid
15. Write down Stiffness matrix for axisymmetric solid
16. Explain plane stress conditions.
17. Explain constitutive relationship for the plane stress problems.
18. State whether plane stress or plane strain elements can be used to model the following structures. Explain your answer.
    a. A wall subjected to wind load
    b. A wrench subjected to a force in the plane of the wrench.
19. Define a plane strain with suitable example.
20. Define a plane stress problem with a suitable example.

PART-B

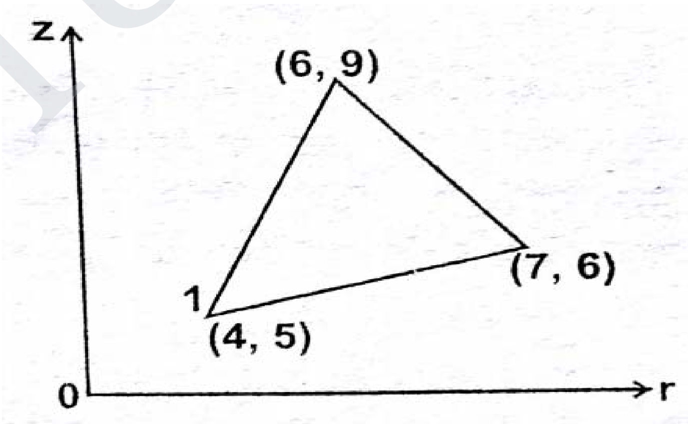
1. Develop elasticity equation for 2D element
2. Develop shape function for axisymmetric triangular elements
3. Develop Stress-Strain relationship matrix for axisymmetric triangular element
4. Develop Strain-Displacement matrix for axisymmetric triangular element
5. Calculate the global stiffness matrix for the plate shown in fig. Taking two triangular elements. Assume plane stress conditions



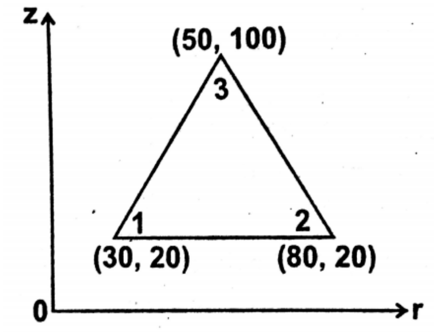
6. Calculate the stiffness matrix for the axisymmetric element shown in fig E= 2.1 x 10^6 N/mm^2 and Poisson's ratio as 0.3



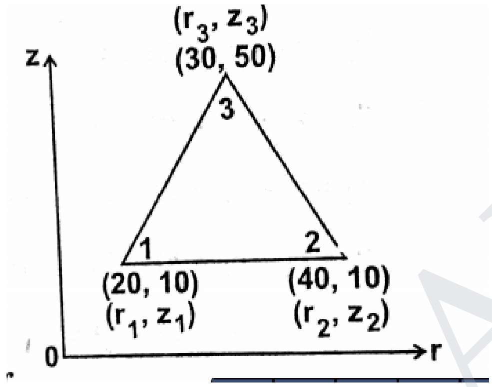
7. Calculate the element strains for an axisymmetric triangular element shown in fig the nodal displacement are. u_1= 0.001, u_2 = 0.002, u_3 = -0.003, w_1 = 0.002, w_2 = 0.001 and w_3 = 0.004 all dimensions are in mm.



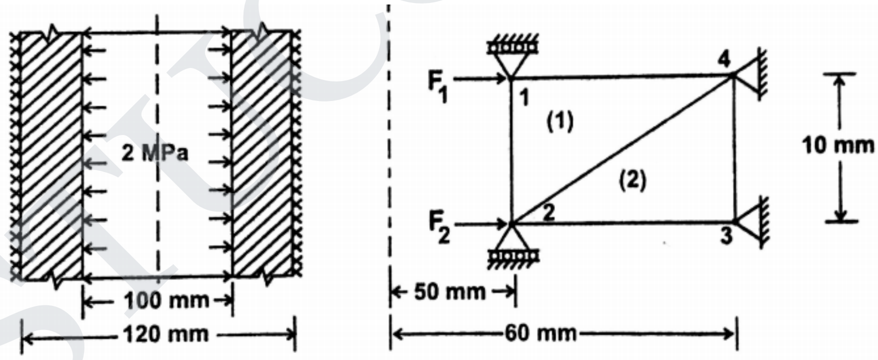
8. For an axisymmetric triangular elements as shown in fig. Evaluate the stiffness matrix. Take modulus of elasticity E = 210 GPa. Poisson's ratio = 0.25. the coordinates are given in millimetres.



9. The nodal coordinates for an axisymmetric triangular element shown in fig are given below. Calculate the strain-displacement matrix for that element



10. 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 (BT3)



UNIT V ISOPARAMETRIC FORMULATION

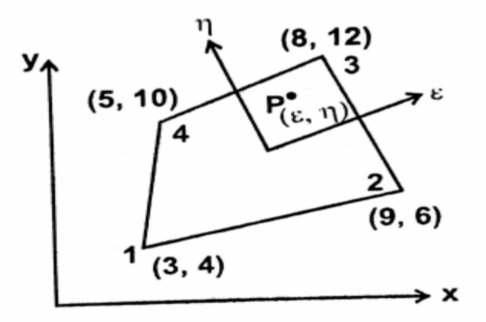
PART-A

1. Define Isoparametric element?
2. Differentiate between Isoparametric, super parametric and sub-parametric elements.
3. Define Isoparametric formulation?
4. Explain the Jacobian transformation?
5. Give the shape functions for a four-noded linear quadrilateral element in natural coordinates.
6. Describe the Jacobian of transformation for two-noded Isoparametric element.
7. List out the advantages of Gauss quadrature numerical integration for Isoparametric element?
8. Discuss about higher order element.
9. Discuss about Numerical integration
10. Discuss about Gauss-quadrature method.
11. Differentiate between implicitly and explicitly methods of numerical integration
12. Differentiate between geometric and material non-linearity.
13. List out the significance of Jacobian transformation?
14. Define Isoparametric element with suitable examples.
15. Develop Stress- displacement matrix for Four noded quadrilateral element using natural coordinates.
16 Develop Stiffness matrix for Isoparametric quadrilateral element
17. Define Newton cotes quadrature method
18. Distinguish between trapezoidal rule and Simpson's rule
19. Distinguish between trapezoidal rule and Gauss quadrature.
20.Explain the transformation for mapping x-coordinate system into a natural coordinate system for a linear spar element and for a quadratic spar element.

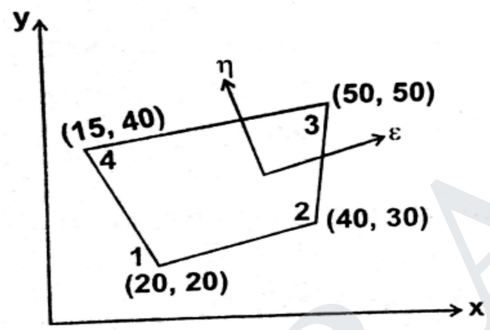
PART-B

1. Develop the shape functions for a four-noded Isoparametric quadrilateral element.
2. Develop Strain-Displacement matrix, Stress-Strain relationship matrix and Stiffness matrix for Isoparametric quadrilateral element

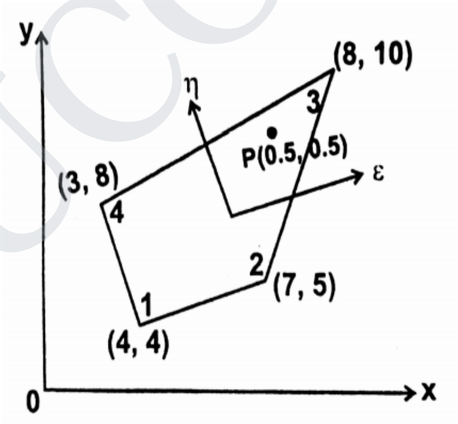
3. Calculate the Cartesian coordinates of the point P which has local coordinates ε = 0.8 and η = 0.6 as shown in figure



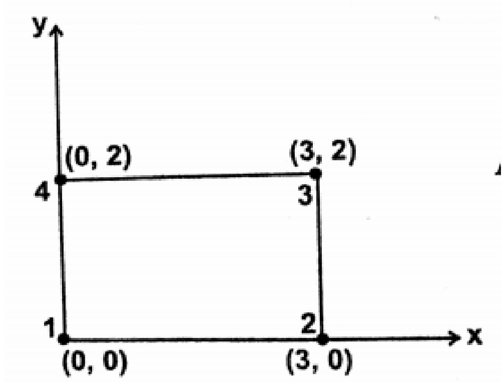
4. For the four noded quadrilateral element shown in fig determine the Jacobian and evaluate its value at the point (1/2, ½)



5. Evaluate the Jacobian matrix at the local coordinates ε=η= 0.5 for the linear quadrilateral element with its global coordinates as shown in fig. Also evaluate the strain-displacement matrix.



6. For a four noded rectangular element shown in fig Calculate the following
   a. Jacobian matrix b. Strain-Displacement matrix c. Element strain and d. Element stress.



7. Find the integral I= $\int_{-1}^{1}(2x^3 + 5x^2 + 6)dx$ using Gaussian quadrature method with 2 point scheme. The Gauss points are ±0.5774 and the weight at the two points are equal to unity.
8. Evaluate the integral $\int_{-1}^{1}(x^4 + 3x^3 - x)dx$
9. Evaluate the integral I= $\int_{-1}^{1}(a1 + a2x + a3x^{32} + a4^3)dx$ using three point Gauss integration.
10. For the element shown in fig. Calculate the Jacobian matrix.