VALLIAMMAI ENGINEERING COLLEGE

SRM- NAGAR, KATTANKULATHUR-603203

DEPARTMENT OF MECHANICAL ENGINEERING

CC7101 - FINITE ELEMENT APPLICATIONS INMANUFACTURING ENGINEERING

QUESTION BANK- ME (CAD / CAM)

First semester

UNIT I – INTEODUCTION

FINITE ELEMENT FORMULATION OF BOUNDARY VALUE PROBLEMS

Part-A

1. State the field to which FEA solving procedure is applicable.
2. What is a structural and non-structural problem?
3. Distinguish between 1D bar element and 1D beam element. (AU Nov/Dec209, May/June 2011)
4. Write the equilibrium equation for an element volume in 3D including the body force.
5. How to write the equilibrium equation for a finite element? (AU Nov/Dec 2012)
6. Write the difference between initial value problem and boundary value problem?
7. What are the different types of boundary conditions? Give examples. (AU April/May 2012)
8. List the various methods of solving boundary value problems. (AU, April/May 2010)
9. State the principle of minimum potential energy. (AU, April/May 2009, Nov/Dec-2007)
10. How will you obtain total potential energy of a structural system? (AU, May/Jun 2012, April/May2011)
11. Write down the potential energy function for a three dimensional deformable body in terms of strain and displacements. (AU, May/Jun 2009)
12. What is Raleigh Ritz method?
13. What is the use of Ritz method? (AU, Nov/Dec 2011)
14. Mention the basic steps of Rayleigh-Ritz method. (AU, Aril/May 2011)
15. Highlight the equivalence and the difference between Rayleigh Ritz method and the finite element method. (AU, Nov/Dec 2012)

16. Distinguish between Rayleigh Ritz method and finite element method with regard to choosing displacement function. (AU, Nov/Dec 2010)
17. Why are polynomial types of interpolation function preferred over trigonometric function? (AU, Aril/May 2019, May/June-2013)
18. What is meant be weak formulation? (AU, May/Jun 2013)
19. What is a weighted residual method? (AU, Nov/Dec 2009)
20. Give two sketches of structures that have both discrete elements and continuum.

PART-B

1. 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. (AU, Nov/Dec 2012)
2. 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

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

(AU, Nov/ Dec-2008)

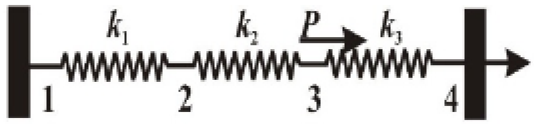
3. If a displacement field is described by

$$u = (-x^2 + 2y^2 + 6xy)10^{-4}$$

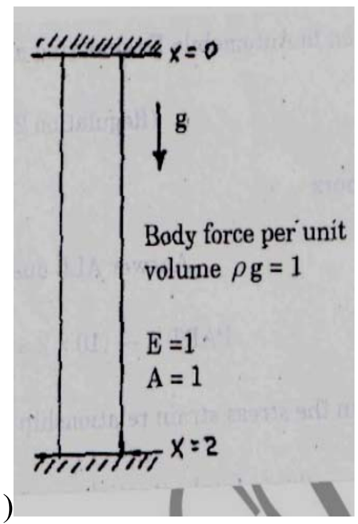
$$v = (3x + 6y - y^2)10^{-4}$$

Determine the direct strains in x and y directions as well the shear strain at the point x =1, y = 0. (AU, April/May 2011)

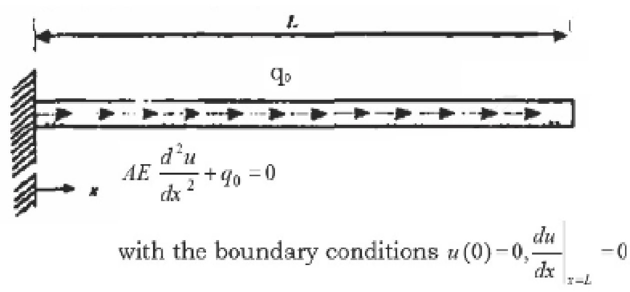
4. For the spring system shown in figure, calculate the global stiffness matrix, displacements on nodes 2 and 3, the reaction force at node 1 and 4. Also calculate the force in the spring 2. Assume k_1-k_3-100 N/m, k_2-200 N/m, u_3-u_4-0 and P-500N. (AU, April/May 2010)



5. Use the Rayleigh Ritz method to find the displacement of the midpoint of the rod shown in figure. (AU, April/May 2011)



6. Find the solution of the problem using Rayleigh Ritz method by considering a two term solution as $y(x) = C_1 x (1-x) + C_2 x^2 (1-x)$ (AU, Nov/Dec – 2009)
7. A simply 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 using Rayleigh-Ritz method and compare with exact solutions. (AU, May/June 2013)
8. 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 using weighted residual method. (AU, April/May 2011)



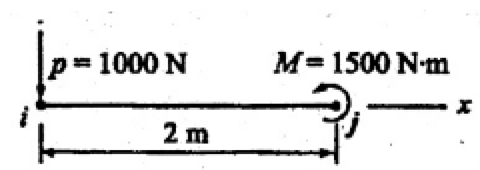
9. Solve the differential equation for a physical problem expressed as $d^2y/dx^2 + 50 = 0$, $0 \le x \le 10$ with boundary conditions as y (0) = 0 and y (10) = 0 using the trial function $y = a_1 x\,(10-x)$ find the value of the parameters a_1 by the following methods. (i) Point collocation method (ii) Sub domain collocation method (iii) Least squares method and (iv) Galerkin method (Nov/Dec 2011)
10. A Physical phenomenon is governed by the differential equation $\frac{d^2w}{dx^2} - 10x^2 = 5 \quad for \quad 0 \le x \le 1$ The boundary conditions are given by $w(0) = w(1) = 0$. By taking two-term trial solution as $w(x) = c_1 f_1(x) + c_2 f_2(x)$ with, $f_1(x) = x\,(x-1)$ and $f_2 = x^2(x-1)$ find the solution of the problem using the Galerkin method. ***[AU, Nov / Dec – 2009]***

UNIT II ONE DIMENSIONAL FINITE ELEMENT ANALYSIS

Part-A

1. What is meant by Shape Function and write down the shape function for one dimensional element? (Nov/Dec 2007, April/May 2009)
2. Draw the shape function of a two noded line element (April/May 2009)
3. Draw the shape function of a two noded line element with one degree of freedom at each node (Nov/Dec2010)
4. Draw the shape function for one dimensional line element with three nodes. (April/May2009)

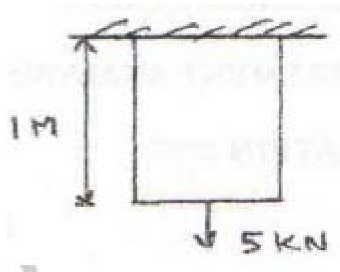
5. State the properties of stiffness matrix. (Nov/Dec 2009, 2010, 2011)
6. List out the stiffness matrix properties. (May/June 2012)
7. State the characteristics of shape functions (May/June 2011)
8. When does the stiffness matrix of a structure become singular? (Nov/Dec 2012)
9. What are the properties of global stiffness matrix? (April/May 2011)
10. Write the properties of Global stiffness Matrix of a one dimensional element (May/June 2012)
11. Why polynomial terms preferred for shape functions in finite element method? (April/May 2011)
12. Distinguish between pane stress and plane strain problems.
13. Differential global and local coordinates. (May/June 2013)
14. Write the element stiffness matrix of a truss element (May/June 2012)
15. Determine the load vector for the beam element in fig. (Nov/Dec 2012)



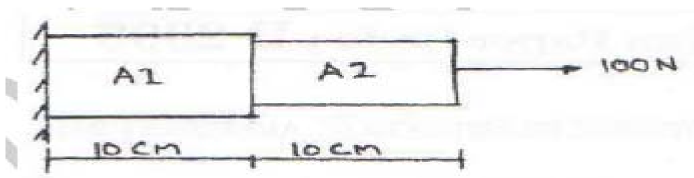
16. Differentiate between sub parametric, isoperimetric and super parametric elements
17. State Fourier's law of heat conduction used in FFA.
18. What is role of Jacobian matrix in FEM?
19. What is aspect ratio of elements? What are its effects?
20. Define a plane stress problem with a suitable example (May/June 2013)

Part-B

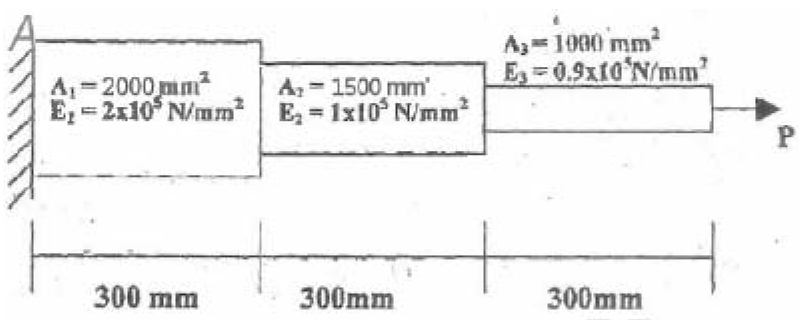
1. A steel rod of length 1m is subjected to an axial load of 5kN as shown in figure. Area of cross section of the rod is 250mm^2. Using 1D element equation solve for the deflection of the bar E = 2 x 10^5 N/mm^2. Use four element (Nov/Dec 2010)



2. Consider a bar as shown in figure. Young's Modulus E = 2 x 10^5 N/mm^2. A_1 = 2cm^2, A_2 = 1cm^2 and force of 100N. Determine the nodal displacement. (Nov/Dec 2010)

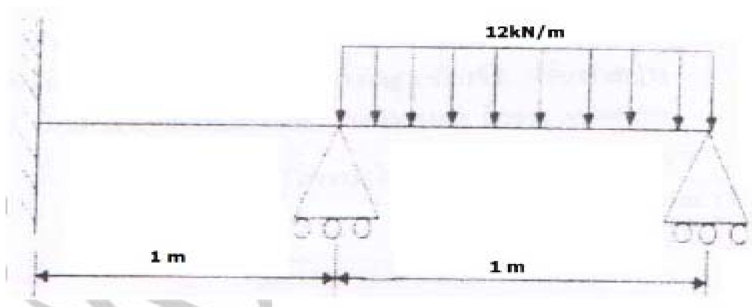


3. Consider the bar shown in figure Axial force P =30 KN is applied as shown. Determine the nodal displacement, stresses in each element and reaction forces. (May/June 2012)

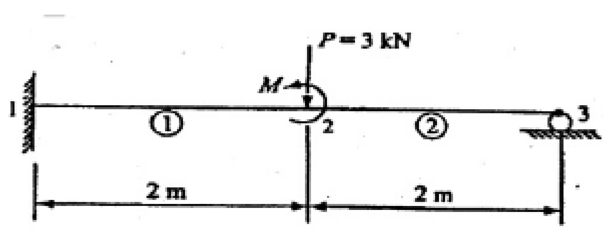


4. Axial load of 500N is applied to a stepped shaft, at the interface of two bars. The ends are fixed. Obtain the nodal displacement and stress when the element is subjected to all in temperature of 100ºC. take E_1 = 70 x 103 N/mm^2, E_2 = 200 x 103 N/mm^2, A_1 = 900mm^2, A_2 = 1200mm^2, α_1 = 23 x 10^{-6} / ºC, α_2 = 11.7 x 10^{-6} / ºC L_1 = 200mm, L_2 = 300mm. (Nov/Dec 2011)

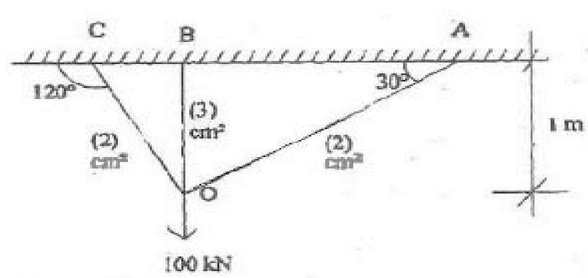
5. For the beam and loading as shown in figure. Determine the slopes at the two ends of the distributed load and the vertical deflection at the mid-point of the distributed load. Take E=200 GPa. And $I=4X10^6$ mm^4



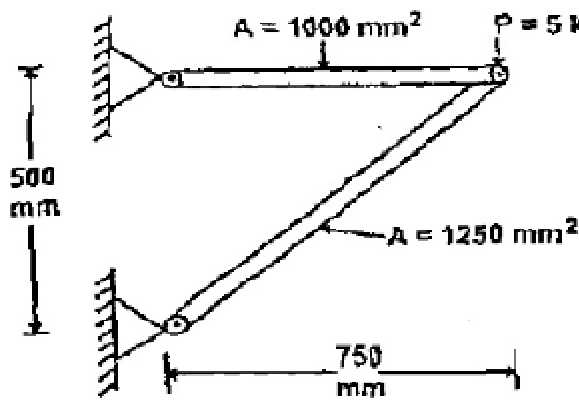
6. Determine the displacements and slopes at the nodes for the beam shown in figure. Find the moment at the midpoint of element 1. (Nov/Dec-2012)



7. Determine the force in the members of the truss as shown in figure. Take E=200GPa. (May/June 2012)

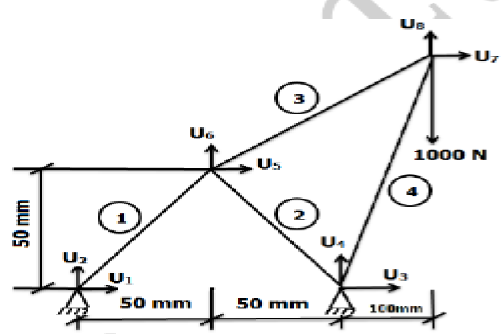


8. The loading and other parameters for a two bar truss element is shown in figure. Determine (i) The element stiffness matrix for each element (ii) Global stiffness matrix (ii) Nodal displacements (iv) Reaction Force (v) The stresses induced in the elements. Assume E=200GPa.



9. Find the nodal displacement developed in the plane truss shown in figure when a vertically downward load of 1000N is applied at node 4. The required data are given in the table. (May/June 2012)

Element No. 'e'	Cross – Sectional area A cm^2	Length $l^{(e)}$ cm	Young's Modulus $E^{(e)}$ N/mm^2
1	2	√2 50	$2 * 10^5$
2	2	√2 50	$2 * 10^5$
3	1	√2.5 100	$2 * 10^5$
4	1	√2 100	$2 * 10^5$



10. Derive the interpolation function for the one dimensional linear element with a length ‘L’ and two nodes one at each end, designed as ‘i’ and ‘j’. Assume the origin of the coordinator systems is to the left of node ‘i’.(April/May 2010)

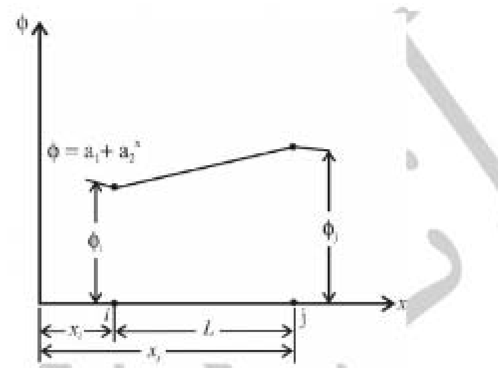


Figure shows the one-dimensional linear element

Unit III TWO DIMENSIONAL FINITE ELEMENT ANALYSIS

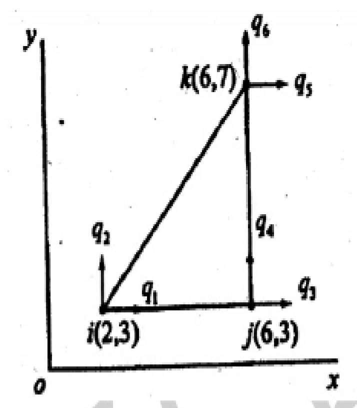
Part-A

1. What is geometric Isotropy? (May/June 2013)
2. Write the Lagrange shape functions for a 1D, 2 noded elements. (Nov/Dec 2008)
3. Why is the 3 noded triangular elements called as a CST element? (Nov/Dec 2010)
4. Write down the interpolation function of a field variable for three-node triangular element. (April/May 2010)
5. What is a CST element? (April/May 2011)
6. Draw the shape functions of a CST element (Nov/Dec 2010)
7. What are CST and LST elements? (Nov/Dec2009)
8. Differentiate CST and LST elements (Nov/Dec 2007, April/May 2009)

9. Evaluate the following area integral for the three node triangular element (May/June 2012)

$$\int N_i N_j^2 N_k^3 \, dA$$

10. A triangular element is shown in figure and the nodal coordinates are expressed in mm. compute the strain displacement matrix.(Nov/Dec 2012)

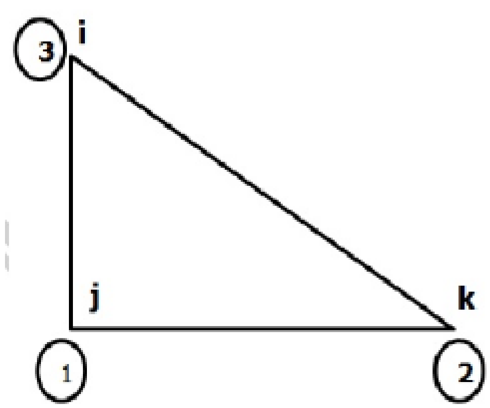


11. Write down the nodal displacement equations for a two dimensional triangular elasticity element (April/May 2010)
12. Write down the strain displacement relation. (April/May 2011)
13. State whether plane stress or plane strain elements can be used to model the following structures. Justify you answer. (Nov/Dec-2012
    a. A wall subjected to wind load
    b. A wrench subjected to a force in the plane of the wrench.
14. How to reduce a 3D problem into a 2D problem? (Nov/Dec 2012)
15. Give examples of axisymmetric problem. (May/June 2012)
16. State the situations where the axisymmetric formulation can be applied (April/May 2011)
17. Express the shape function of four node quadrilateral elements. (May/June 2012)
18. Show the transformation for mapping x-coordinate system into a natural coordinate system for a linear spar element and for a quadratic spar element. (Nov/Dec-2012)

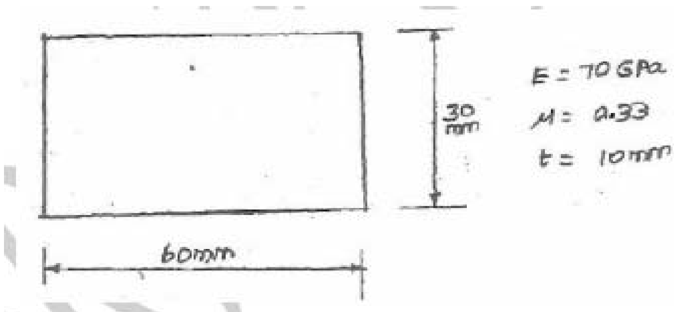
19. Define Isoparametric elements with suitable examples (April/May 2010)
20. What is the significance of Jacobian transformation? (May/June 2012)

Part-B

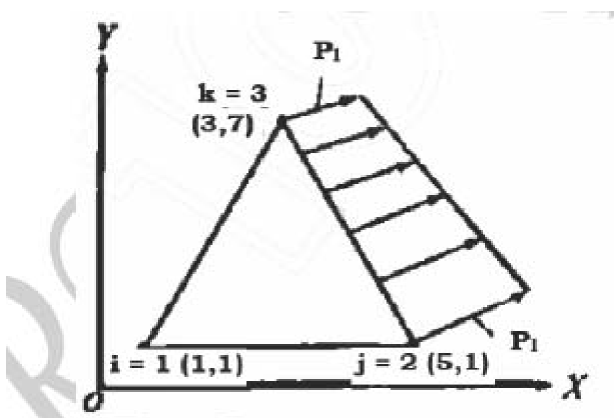
1. Derive the element strain displacement matrix and element stiffness matrix of a CST element (April/May 2011)
2. A two noded line element with one translational degree of freedom is subjected to uniformly varying load of intensity P_1 at node 1 and P_2 at node 2. Evaluate the nodal load vector using numerical integration. (Nov/Dec 2012)
3. The (x,y) coordinates of nodes i, j and k of a 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.(Nov/Dec-2009)
4. Consider the triangular element show in figure. The element is extracted from a thin plate of thickness 0.5 cm. the material is hot rolled low carbon steel. The Nodal coordinates are $x_i = 0$, $y_i = 0$, $x_j = 0$, yj = -1 and $x_k = 0$, $y_k = -1$cm. determine the elemental stiffness matrix. Assuming plane stress analysis. Take μ=0.3 and E= 2.1 x 107 N/cm^2 (May/June2012)



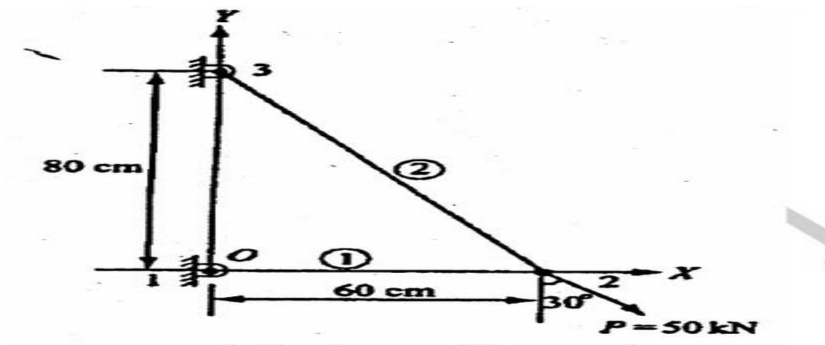
5. Obtain the global stiffness matrix for the plate shown in figure. Taking two triangular elements. Assume plane stress condition (May/June 2012)



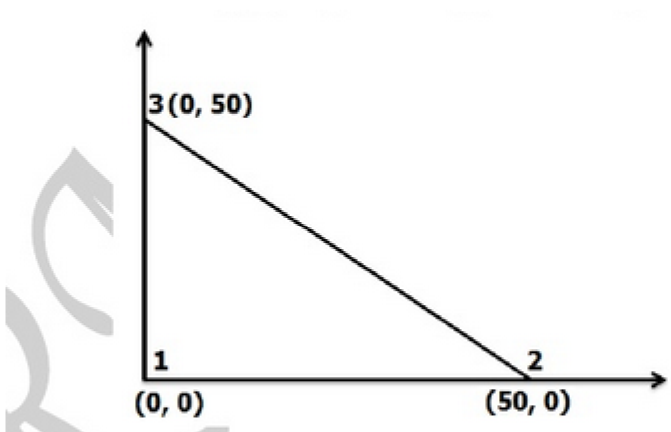
6. Derive element force vector when linearly varying pressure acts on the side joining nodes jk of triangular element shown in figure and body force of 25N/mm^2 acts downwards. Thickness = 5mm. (April/May 2011)



7. Calculate nodal displacement and elemental stresses for the truss shown in figure. E=70GPa cross-sectional area A=2cm^2 for all truss members. (Nov/Dec 2012)



8. Derive the stress-strain relationship matrix (D) for the axisymmetric triangular element. (Nov/Dec 2012)
9. Determine the stiffness matrix for the axisymmetric element shown in fig take E as 2.1 x 106 N/mm^2 and Poisson's ratio as 0.3



10. Derive the shape function of a nine node quadrilateral Isopapametric element (April/May-2011, May/June 2012)

Unit IV ANALYSIS OF PRODUCTION PROCESSES

Part - A

1. What is incrementation?
2. What is at time stepping process?

3. Specify the different methods of generation of mesh.
4. Explain chip separation.
5. How can the plasticity of the material be defined in any FEA commercial preprocessor?
6. Define the team flow formulation?
7. Define forming?
8. Describe discrete model?
9. What is meant by plasticity?
10. Define gap element.
11. List out gap element techniques.
12. List the types of dynamic analysis problems (May/June 2012)
13. Define normal modes. (May/June 2013)
14. Define Coulomb function.
15. Define constant Shear stress function.
16. Differentiate shear in stricking Zone and Sliding Zone.
17. Write down Finite element software packages.
18. Application of Software packages.
19. Define clearance angle and rake angle.
20. Define work bench modeling.

Part-B

1. Derive the equilibrium equations governing the behavior of the stress components in a solid when the point is in the interior of the body.
2. Explain how the Nicholson algorithm is used in the prediction of grain structure.
3. Explain in details finite element analysis of metal cutting process.
4. Briefly explain the concepts of plasticity in manufacturing engineering?
5. Explain Lagrangian and Eulerian formulation of solid mechanics problems.
6. Explain in details adaptive mesh generation procedure.

7. How the grains structure and explain methods of grains formation methods.
8. Explain in details time stepping procedure for metal cutting operation.
9. How the chip separation criteria are fixed? Detail below.
10. Explain incorporation of strain rate dependency in metal cutting process.

Unit V COMPUTER IMPLEMENTATION

Part-A

1. Define band width.
2. Explain node and elements in details.
3. How can select material section in Ansys.
4. Define types of boundary condition.
5. Define squeeze.
6. How to develop codes in Ansys.
7. What is meant by grid generation?
8. List out list of grid generation methods.
9. How to give input condition of materials.
10. What is meant by work bench?
11. What are tools are included in work bench?
12. Write down the one dimensional heat conduction equation. (April/May 2011)
13. Write down the expression of shape function and temperature function for one dimensional heat conduction. (April/June 2011)
14. Define static condensation. (Nov/Dec-2010)
15. Give the governing equation of torsion problem (May/June 2012)
16. Define streamline. (May/June 2012)
17. Define the stream function for a one-dimensional incompressible flow. (April/May2011)
18. List the method of describing the motion of fluid. (May/June 2012)
19. State the relation between the velocity of fluid flow and the hydraulic gradient according to Darcy's law, explaining the terms involved (Nov.Dec-2012)

20. Define the stream function for a two dimensional incompressible flow. (May/June 2013)

Part-B

1. Briefly Explain the following:
   a. Mesh generation process
   b. Application on ANSYS in fluid flow analysis.
2. Explain the method code generation for a one dimensional heat transfer problems.
3. What is element connectivity? And explain in details.
4. Explain the term degenerate element.
5. Briefly explain pre-processing of ANSYS fluent software.
6. How to extract the result from ANSYS software with post processing explains in details.
7. Explain methods of coding in one dimensional analysis and two dimensional analyses.
8. Explain in details boundary condition implementation on ANSYS software package.
9. How to do volume meshing in finite element analysis? Explain in details.
10. What are the methods involved in transferring work in the finite element analysis packages? Explain any five in details.