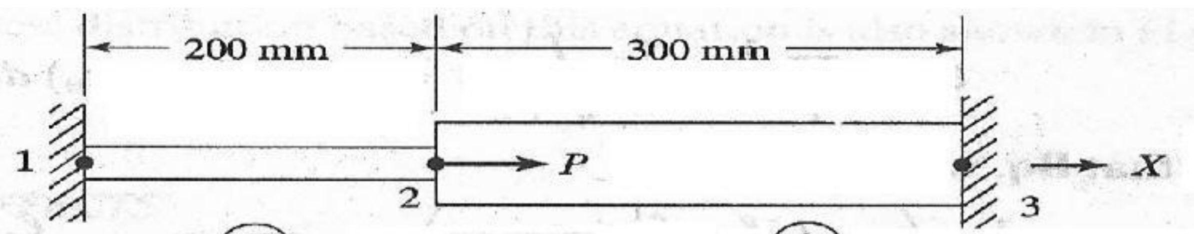
FINITE ELEMENT METHODS (FEM)

UNIT – 1

1. What are the advantages and disadvantsges of FEM? And its applications?
2. Explain about weighted residual methods?
3. Explain the following weighted residual types
   a) Point collocation method
   b) Sub-domain collocation method
   c) Least square methaod
   d) Galarkin's method
4. Discuss about the steps involved in FEM?
5. Using variational approach (potential energy),describe FE formulation for 1D bar element
6. Describe elimination approach with an example?
7. Discuss in detail about the concepts of FEM formulation. How is that FEM emerged as a powerful tool?
8. An axial load P=300X10^3 N is applied at 20^0 C to the rod as shown in figure below. The temperature is the raised to 60^0 C.
   a) Assemble the K and F matrices.
   b) Determine the nodal displacements and stresses.



FIGURE

① Aluminum	② Steel
$E_1 = 70 \times 10^9$ N/m²	$E_2 = 200 \times 10^9$ N/m²
$A_1 = 900$ mm²	$A_2 = 1200$ mm²
$\alpha_1 = 23 \times 10^{-6}$ per °C	$\alpha_2 = 11.7 \times 10^{-6}$ per °C

UNIT – 2

1. Write a short note on following:

   a) Discretization of domain
   b) Band width
   c) Node numbering
   d) Mesh generation

2. Explain about the treatment of boundary conditions and also about the convergence requirements?

3. Determine the nodal displacements, element stress for axially loaded bar as shown in the figure below

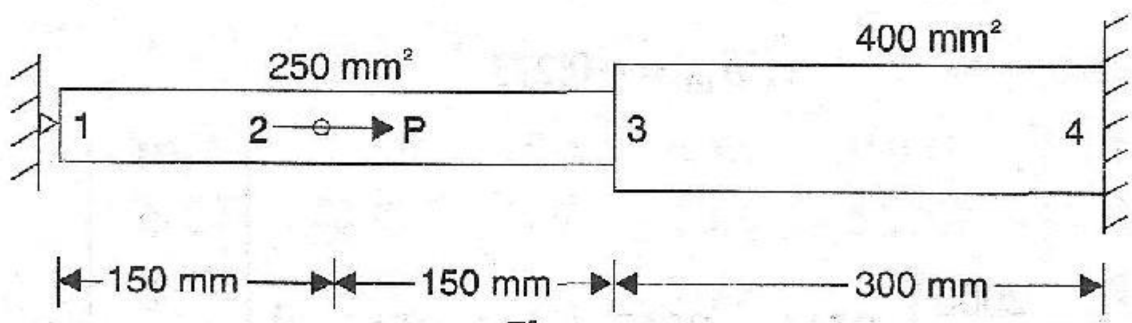
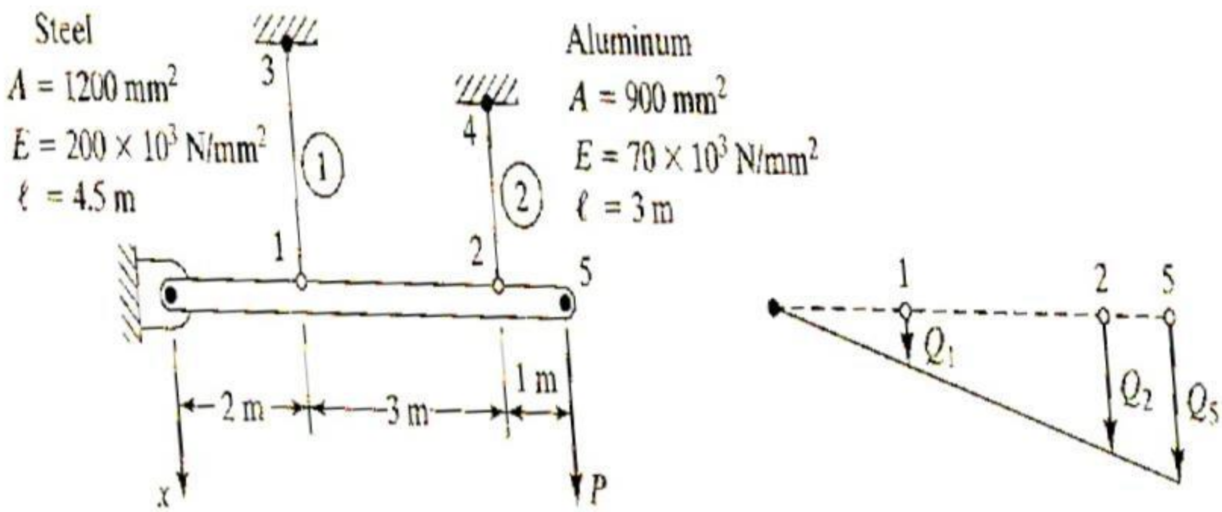


Fig.

4. Derive element stiffness matrix and load vector for linear element using potential energy appraoach

5. Consider the structure shown in fig. A rigid bar of negligible mass, pinned at one end, is supported by a steel rod and an aluminum rod. A load P=30 KN.N is applied as shown

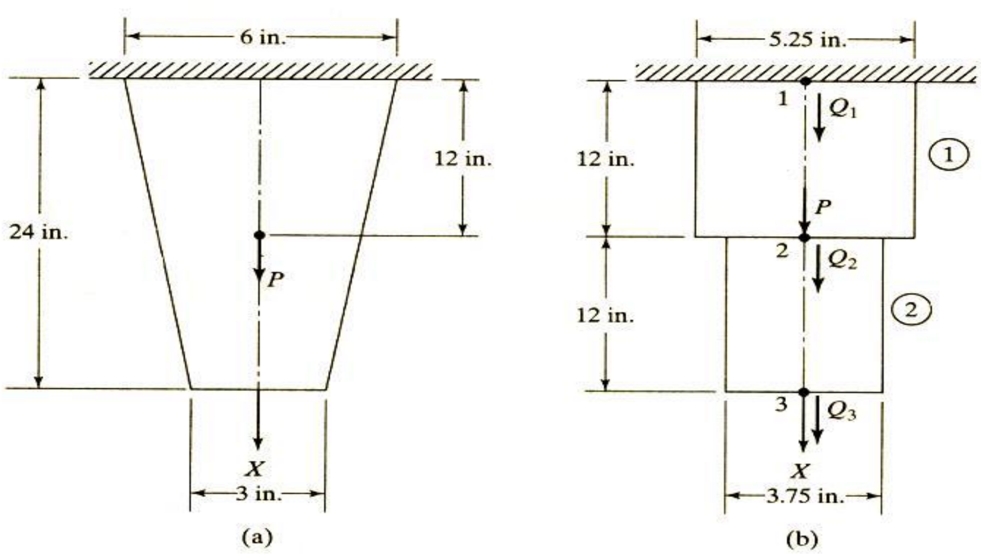


Assemble stiffness matrix and determine nodal displacement for above bar element.

6. Consider the thin (steel) plate in fig. the plate has a uniform thickness t=10 mm; Young's modulus E=100Gpa; and weight density=78500N/M^3. In addition to its self-weight, the plate is subjected to a point load P=60N at its midpoint.

a) Write down expression for the element stiffness matrices and element body force vectors

b) Evaluate the stress in each element. Determine the reaction force at the support. Consider 1 in=1 cm for SI units.



8. A bar is subjected to an axial force is divided into a number of quadratic element. For a particular element the nodes 1,3,2 are located at 15mm, 18mm and 21mm respectively from origin. If the axial displacements of the 3 nodes are given by u_1=0.00015mm, u_3=0.0033 and u_2=0.00024mm. determine the following
   a) Shape function
   b) Variation of the displacement u(x) in the element
   c) Axial strain in the element

   Derive the thermally induced stress in the 2 noded bar element.
9. Derive the element stiffness and load vector using Galerkin approach.

UNIT – 3

1. Represent the truss in local and global coordinate system?
2. What is the expression for an element stiffness matrix of a truss in local coordinate system?
3. What is the expression for an element stiffness matrix of a truss in global coordinate system?
4. Assemble the global stiffness matrix and nodal displacement-for the fig. shown below solve the problem by using SI units only. Take 1lb = 4.44N 1 in^2=645.16mm^2 . 1 Psi=6.89 KP 1in=25.4mm

5. For two bar truss shown in figure below, determine the nodal displacements, element stress and support reactions and a force of P=1000KN is applied at node-1. Assume E=210GPa and A=600mm^2 for each element.

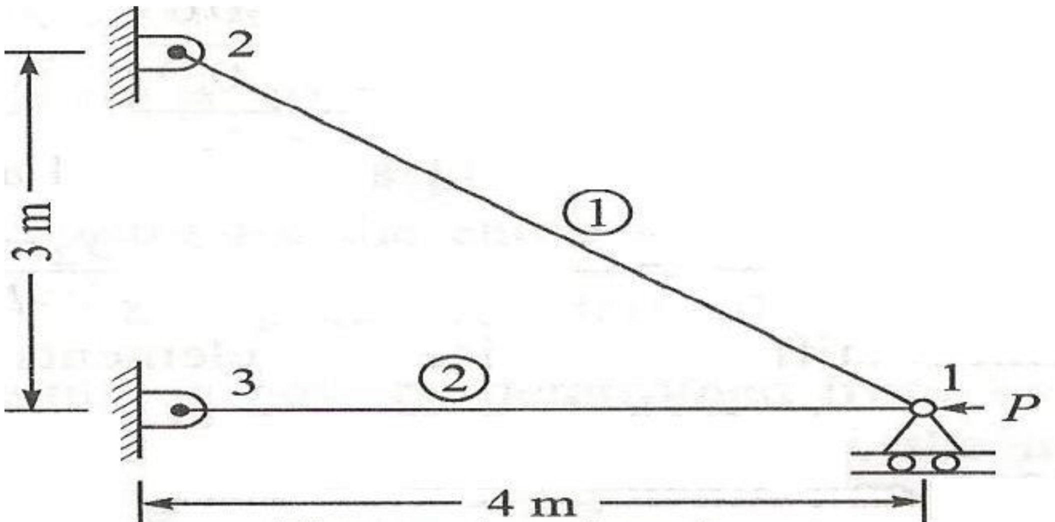


Figure two-bar truss.

5. Obtain the force in plain truss shown in figure below. And determine the support reactions also . Take E=200GPa and A=2000mm^2.

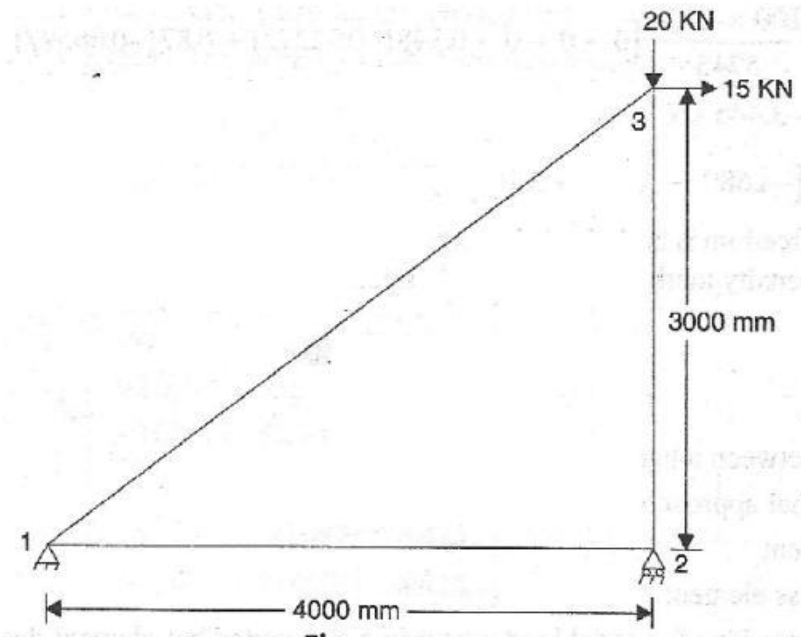


Fig.

6. A) Distinguish between local, natural and global coordinates.

B) For the pin jointed configuration shown in figure. Determine ;

1.Displacement 2.Element stress

Given $\alpha=10\times10^{-6}$ per OC $\Delta T=50^0$ C.

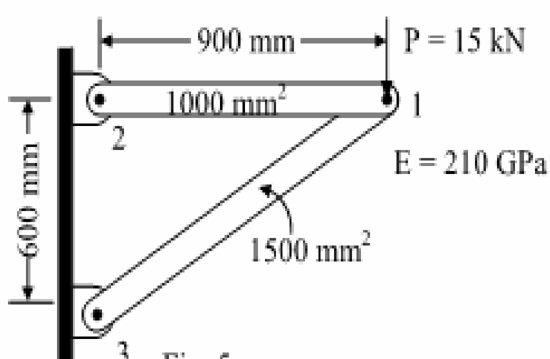
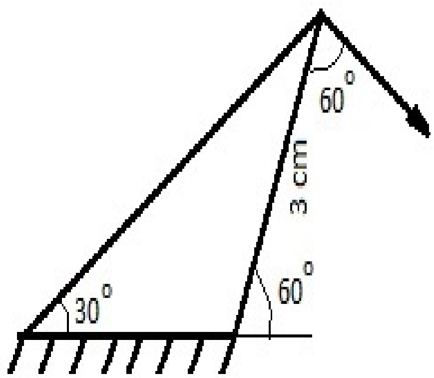


Fig. 5

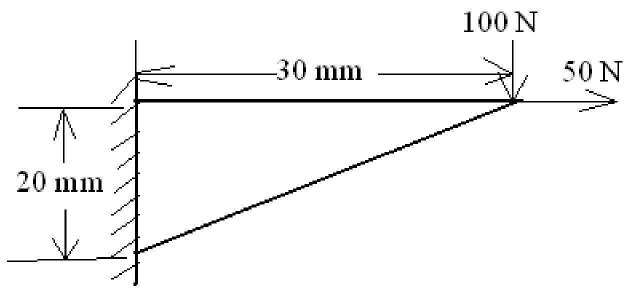
7. Calculate nodal displacements and element stress for the members shown in figure
   E=2000GPa , A=500mm^r and P=25KN.



8. Derive the stiffness matrix for $a^1{}_a$ 2D truss element .
9. Derive the stiffness matrix for a 3D truss element.
10. Derive the Hermite functions for a beam element.
11. Draw beam element in global and intrinsic coordinate system.
12. Derive element stiffness for a beam element.

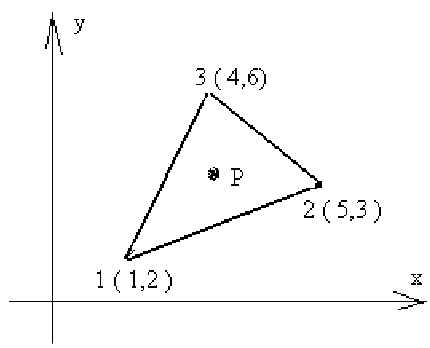
UNIT – 4

1. What is a two dimensional element . list any four two dimensional elements?
2. Enumerate some of the applications of 2-D elements and What do you mean by discretizing of 2-D elements.
3. a) Explain iso-parametric, sub-parametric and super-parametric elements. **b)** Advantages of iso-parametric elements c) write short notes on Gaussian quadrate integration technique
4. Derive the strain displacement matrix for triangular element.
5. For the configuration shown in figure, determine the deflection at the point load application using one element model . T=10mm E=70GPa v=3.



6.a) explain the convergence requirements.

b)The nodal coordinates of the triangular elements is shown in figure ; at the interior point P, the x-coordinates is 3.3 and N_1=0.3. determine N_1, N_2 and the y-coordinates of the point P.

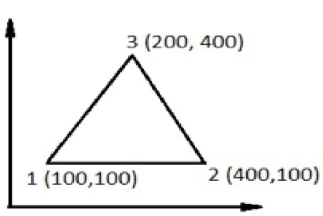


7. a) Evaluate the integral I=$\int\int$ $2x^2 + 3xy + 4y^2$)dx dy in the limits of -1 to +1 using gauss quadrature numerical integration

b) verify with exact solution

8. Determine the nodal displacements and element stress for the 2 dimensional loaded plate as shown in fig. assume the plane stress conditions. Body force may be neglected in comparision to the external forces.

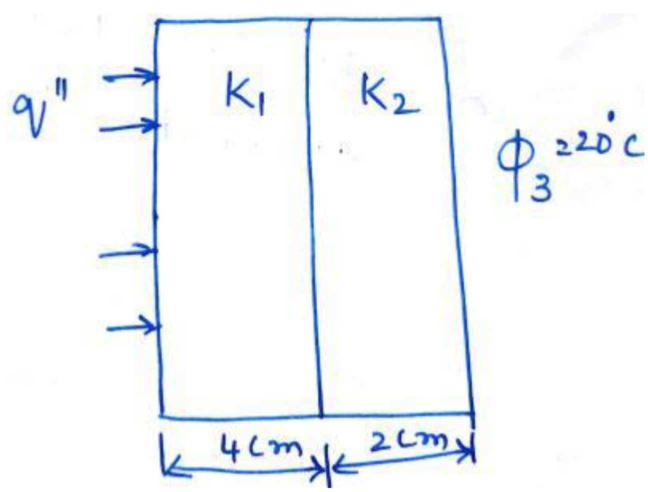
Take E=210GPa μ=0.25; thickness=10mm;



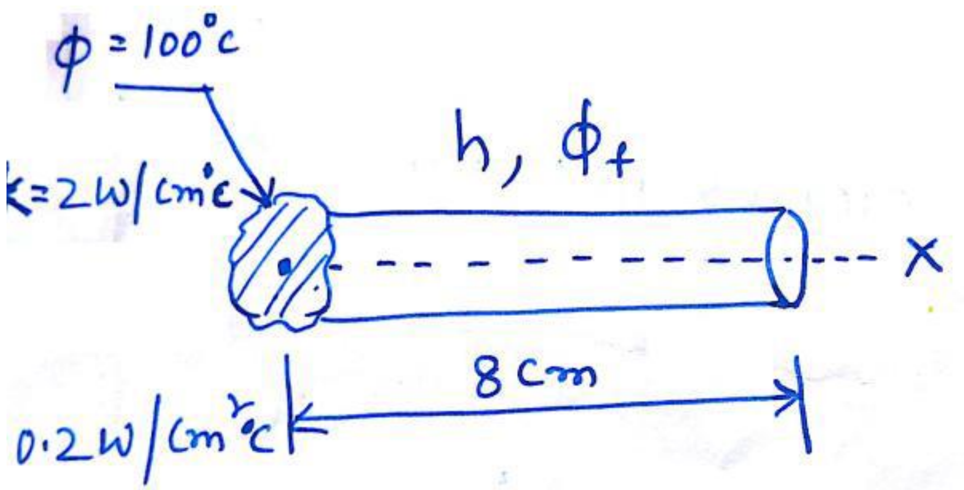
10. determine the shape functions for a 8 node quadratic quadrilateral element (boundary noded)

UNIT – 5

1. Derive thermal stiffness matrix for one dimensional heat conduction with lateral surface convection and with internal heat generation.
2. Describe heat transfer analysis for composite wall
3. Describe heat transfer analysis for straight fin
4. Derive the strain displacement matrix for 2D-thin plate . consider the temperature field with in the triangular element is given by $T=N_1T_1+N_2T_2+N_3T_3$.
5. Describe heat transfer analysis for tapered fin.
6. Determine the temperature at the nodal interfaces for the two layered wall shown in fig. the left face is supplied with heat flux of $q^{11}=5w/cm^2$
   $Q^u=5w/cm^2$
   $K_1=0.2W/cm^0C$
   $K_2=.0.6W/cm^0C$
   $A=1cm^2$.



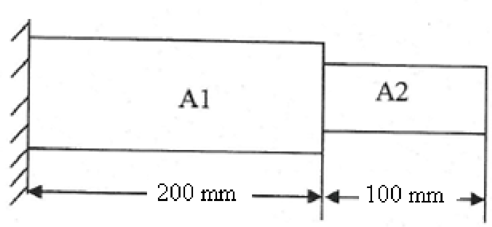
7. Write down the differential equations of 1D steady state heat conduction problem.
8. Calculate the nodal temperature using 1 D analysis of a fin. As shown in fig.
   Base of the fin in maintained at 100^0C at tip of the fin is insulated. Thermal conductivity $K=2W/cm^0C$, convective heat transfer co-efficient $H=0.2W/cm^2$, $Ø_f=20^0C$ (fluid temperature) and diameter of the fin=1cm .



9. Derive one dimensional steady state heat conduction equation and apply to one dimensional fin problem.
10. Derive element equation for one dimensional heat conduction element by considering the weak form.

UNIT – 6

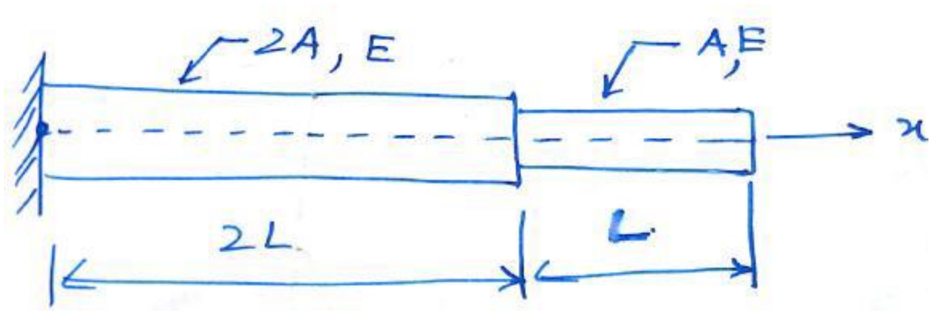
1. A)Evaluate natural frequencies for the stepped bar shown in figure. In axial vibration . take E=200GPa and density=7580kg/m^3.
   B) draw mode shapes and determine Eigen vector. Take A_1=400mm^2 and A_2=200mm^2 using characteristics polynomial method.



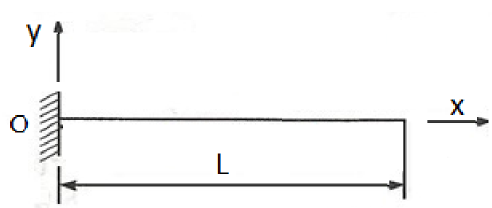
2. Explain the following with examples : a) lumped parameter model
   b)continuous system model

3. Evaluate natural frequencies for the cantilever beam using 1 element.

4.derive the Eigen value and eigen vector and mode shapes of the given stepped bar element .when L=length; A= area of cross section; E=modulus of electivity and P= density of the material.



5 . Derive approximate the first two natural frequencies of cantilever beam using one element module. EI=flexural rigidity.



6 . Distinguish between consistant mass matrix and lumped mass matrices.

7 . Derive the elemental mass matrix for 1-D and 1-D plane truss element.

8 . Determine the natural frequencies and mode shapes of stepped bar shown in figure below using the characteristics polynomial technique. Assume E=300GPa and density=7800kg/m^3

9 . State the method used for obtaining natural frequencies and corresponding Eigen vectors?

10 . From first principles derive the general equation for elemental mass matrix?