UNIT-I. INTRODUCTION:

1. Classify boundary conditions.

(i) Displacement based.

(ii) Stress based.

2. Name the weighted Residual methods.

(i) Point collocation.

(ii) Sub-domain collocation.

(iii) Least square.

(iv) Galerkin.

3. What is the limitations of using a Finite difference methods?

(i) Used to solve Heat transfer, Fluid Mechanics (FM) problems.

(ii) Suitable for 2D regions with boundaries parallel to co-ordinate axis.

(iii) Difficult to use when regions have curved or, irregular boundaries.

4. List the various methods of solving boundary value problems.

(i) FDM - Finite difference Method.

(ii) FEM - Finite Element Method.

5. What is Galerkin method of approximation.

$$\Rightarrow \int_0^l R \cdot W_i \cdot dx = 0.$$

6. Write down the boundary conditions of a cantilever beam 'AB' of span & fixed at 'A' & free at 'B' subjected to a uniformly distributed load of 'p' throughout the span.

- $y = a_1 \sin\frac{\pi x}{l} + a_2 \cdot \sin\frac{3\pi x}{l} + a_3 \cdot \sin\frac{5\pi x}{l} + \cdots$
- Boundary conditions are, $\frac{\partial \pi}{\partial a_1} = 0$; $\frac{\partial \pi}{\partial a_2} = 0$ & $\frac{\partial \pi}{\partial a_3} = 0$.

7. Write the potential energy for beam of span 'L' simply supported at ends subjected to a concentrated load 'P' at midspan. Assume EI constant.

- Potential energy of beam,

where, $\Pi = \frac{EI\pi^4}{4L^3}\left[a_1^2 + 81a_2^2\right] - W(a_1 - a_2)$.

8. What should be considered during piecewise trial functions?

* Continuity of the field variables, &
* its derivatives at the junctions.

9. Mention the basic steps of Rayleigh - Ritz method.

(i) Assume a displacement field.
(ii) Evolution of the total potential energy.
(iii) Setup & solve the system of equations.

10. List the types of nodes.

(i) Exterior.
(ii) Interior.

11. What is interpolation function?

The function used to represent the behaviours of the field variable within an element is called.

12. What is meant by weak formulation?

A weak form is a weighted-integral statement of a differential equation in which the differentiation is distributed among the dependent variable & the weight function & also includes the natural boundary conditions of the problem which is known as.....

13. Why are polynomial type of interpolation function preferred over trigonometric functions.

(i) It is easy to formulate & computerize the FE equations.

(ii) It is easy to perform differentiation & integration.

(iii) The accuracy of the results can be improved by increasing the order of the polynomial.

14. What is meant by post-processing.

✓ Analysis & Evaluation of the solution results is referred to as post-processing.

✓ Post-processor computer programs help the user to interpret the result by displaying them in graphical form.

15. What is the difference b/w static & Dynamic analysis.

Static Analysis.

* The solution of the problem doesn't vary with time.
* Accuracy is more.
* Ex:- stress analysis of beam.

* The solution of the problem varies with time.
* Accuracy is less.
* Ex:- Flow & Vibration analysis.

16. Name any FEA softwares.

* ANSYS.
* ABAQUS.
* COSMOS.
* NX-Nastran.
* SAP.
* NISA.

UNIT-II 1-D PROBLEMS.

1. What are the types of problems treated as 1D problems?

* Structural Elements - Bars & rods.
* Heat transfer problems - Fins, Wall.
* Fluid flow problems.
* Elastic spring systems.

2. Define normal modes.

When a system vibrates with a given natural frequency 'ω_i' the corresponding unique shape with arbitary amplitude corresponding to 'ω_i' is called....

3. Define element capacitance matrix for un-steady state heat transfer problems.

$$[k_3^{fe_2}] = \iiint_{V(e)} \rho L\, [N]^T \{N\, dv\}.$$

4. List the type of dynamic analysis problems.

(i) Wave propagation.
(ii) Structural dynamics.

5. List out the stiffness matrix property.

(i) It is a symmetry matrix.
(ii) In any column, sum of element is equal to zero.
(iii) The determinant is always equal to zero.
(iv) N×N is the dimension of the global stiffness matrix.
(v) The diagonal co-efficient are always (+ve) positive.

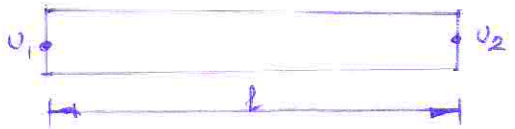
6. When do we resort to 1-D quadratic spar elements.

(i) Better accuracy.

(ii) Representation of curved boundaries.

(iii) Faster convergence.

7. Write the shape function for 1-D, 2 node element.



✓ $N_1 = \frac{l-x}{L}$.

✓ $N_2 = \frac{x}{l}$.

8. Define shape function.

- It is a function which interpolates the solution b/w the discrete values obtained at the nodes.
- It is used to express the geometry (or) shape of the element.
- $\phi(x,y) = N_1(x,y)\phi + N_2(x,y)\phi_2 + N_3(x,y)\phi_3$.

9. State the assumptions made while finding the force in a truss.

(i) All the members are pin joined.

(ii) The truss is loaded only at the joints.

(iii) The self-weight of the members are neglected unless stated.

10. Determine the element mass matrix for 1-D dynamic structural analysis problem. Assume, 2 noded linear element.

$$\begin{Bmatrix} F_1 \\ F_2 \end{Bmatrix} = \frac{AE}{L} \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} \begin{Bmatrix} u_1 \\ u_2 \end{Bmatrix}.$$

11. What is meant by dynamic analysis.

* It is an analysis to find out the response of a system as a function of time with respect to external disturbances.

* the state should be unsteady or, transient.

12. Write stiffness matrix equation for 1-D heat conduction element.

$$[K]\{T\} = \{F\}$$

where, $[K]$ - stiffness matrix.

$[T]$ - Temperature.

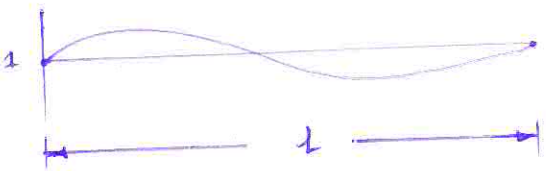
$\{F\}$ - Thermal load vector.

13. Name the boundary conditions involved in any heat transfer analysis.

(i) Heat flux.

(ii) Forced & natural.

14. Draw the shape functions of a 2-noded line element.



$$N_1 = \frac{l-x}{l}.$$

$$N_2 = \frac{x}{l}.$$

15. Draw the shape functions of an 1-D line element with 3-nodes.

16. Write down the lumped mass matrix of truss element.

$$\Rightarrow m^e = \frac{l A_e l_e}{2} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}.$$

UNIT-III. 2D SCALAR VARIABLE PROBLEMS.

1. What is geometric isotropy?

The displacement shape should not change in local co-ordinate system. This property is known as .....

(b) 2. Define a plane stress problem with suitable examples.

It is defined as a state of stress in which the normal stress (σ) & shear stress (τ) directed perpendicular to the plane are assumed to be zero.

Example: plate with hole.

3. What is interpolation functions?

The behaviour of the field variable within an element are called .....

4. Evaluate the following area integrals for the 3-node triangular element. $\int N_i N_i^2 N_k^3 dA$.

$$\int N_i N_i^2 N_k^3 dA = \frac{1!\,2!\,3!}{(1+2+3+2)!} \times 2A = \frac{1 \times 2 \times 1 \times 3 \times 2 \times 1}{8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1} \times 2A$$

$$= \frac{A}{1680}.$$

5. What are higher order elements & why are they preferred?

- For any element, if the interpolation polynomial is the order of 2 or more, that element is known as.....
- It is used to represent the curved boundaries.
- The no. of elements are reduced when compared with straight edge elements to model geometry.

6. Distinguish b/w plane stress & plane strain problems.

plane stress.

It is defined to be a state of stress in which the normal stress (σ) & shear stress (τ) directed perpendicular to the plane are assumed to be zero.

plane strain.

It is defined to be a state of strain in which the normal strain to xy plane & the shear strains are assumed to be zero.

7. what are the difference b/w 2D scalar variable & vector variable elements.

2-D scalar variable Element.

* It has only one direction independent variable per node.
* Stiffness matrix size = 3×3.

2D vector variable Element.

* It has direction dependent variable at each node.
* stiffness matrix size = 6×6.

8. Explain the important properties of CST element.

(i) The strain components are constant throughout the volume of the element.

(ii) 6 DOF (Degrees of Freedom) = 6 Displacement Variables.

9. What is CST element.

- CST – Constant triangular element is nothing but the 3-noded triangular element (Δ)

- 6 Degrees of Freedom (DOF), because it has 6 unknown displacements.

- Advantages: Calculation of stiffness matrix is easier.

- Dis-advantages: Result will be poor.
(Strain variation within the element is Constant)

10. Write a displacement function equation for CST element.

$$U = \begin{Bmatrix} u(x,y) \\ v(x,y) \end{Bmatrix} = \begin{bmatrix} N_1 & 0 & N_2 & 0 & N_3 & 0 \\ 0 & N_1 & 0 & N_2 & 0 & N_3 \end{bmatrix} \begin{Bmatrix} u_1 \\ v_1 \\ u_2 \\ v_2 \\ u_3 \\ v_3 \end{Bmatrix}$$

11. Write the strain-displacement matrix for CST element.

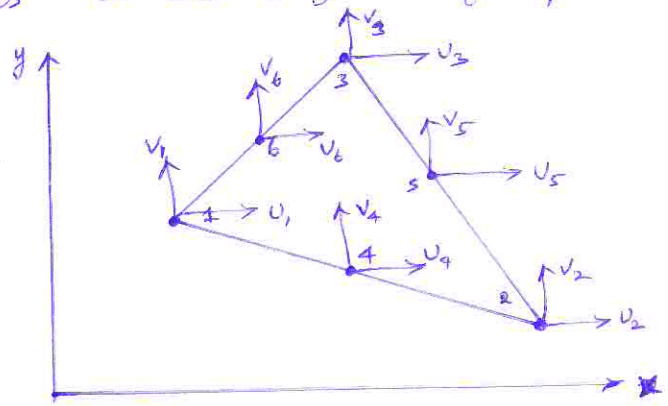
$$[B] = \frac{1}{2A} \begin{bmatrix} y_2 - y_3 & 0 & y_3 - y_1 & 0 & y_1 - y_2 & 0 \\ 0 & x_3 - x_2 & 0 & x_1 - x_3 & 0 & x_2 - x_1 \\ x_3 - x_2 & y_2 - y_3 & x_1 - x_3 & y_3 - y_1 & x_2 - x_1 & y_1 - y_2 \end{bmatrix}$$

(or)

$$[B] = \frac{1}{2A} \begin{bmatrix} q_1 & 0 & q_2 & 0 & q_3 & 0 \\ 0 & r_1 & 0 & r_2 & 0 & r_3 \\ r_1 & q_1 & r_2 & q_2 & r_3 & q_3 \end{bmatrix}.$$

12. Define LST element.

* LST - Linear strain Triangular element.
* 6 nodes & 12 Degrees of freedom.



13. Differentiate CST element with LST element.

CST	LST
* 3-noded triangular element.	* 6-noded triangular element.
* Degrees of Freedom = 6.	* Degrees of Freedom = 12.

14. How do you define 2-D element.

* 2-D elements are defined by 3 (or) more nodes in a 2D plane (x, y).

* The basic element is — Triangular element.

(b) 15. Define plane strain analysis.

It is defined to be a state of strain in which the strain normal to the xy plane & the shear strains are assumed to be zero.

16. Write down the nodal displacement equations for a 2D triangular elasticity element.

$$[B] = \frac{1}{2A}\begin{bmatrix} y_2 - y_3 & 0 & y_3 - y_1 & 0 & y_1 - y_2 & 0 \\ 0 & x_3 - x_2 & 0 & x_1 - x_3 & 0 & x_2 - x_1 \\ x_3 - x_2 & y_2 - y_3 & x_1 - x_3 & y_3 - y_1 & x_2 - x_1 & y_1 - y_2 \end{bmatrix}$$

UNIT-IV 2D VECTOR VARIABLE PROBLEMS.

1. What is axisymmetric element.

Many 3D problems in Engineering exhibit symmetry about an axis of roration. Such type of problems are solved by a special 2D element is called .....

2. What are the four basic sets of elasticity equation.

(i) Equilibrium equation.
(ii) Compatibility equation.
(iii) Strain-displacement relationship equation.
(iv) Stress-Strain relationship equation.

3. Give four applications of axisymmetric elements.

* Pressure vessels.
* Rocket castings.
* Cooling towers.
* Sub-marine hills.
* Springs.

4. What is effect of the element distortion in the analysis results?

It affects the accuracy of stress distribution.

5. What is plane stress analysis.

It is defined to be a state in which the normal stress (σ) & shear stress (τ) directed perpendicular to the plane are assumed to be zero.

6. what is plane strain analysis.

It is defined to be a state of strain in which the strain normal to the 'xy' plane & the shear strain are assumed to be zero.

UNIT-V ISOPARAMETRIC FORMULATION

1. Write down the stiffness matrix equation for 1-D heat conduction element.

$$[k]\{T\} = \{F\}.$$

where,

$$[k_c] = \frac{Ak}{l}\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}.$$

2. Write down the interpolation function of a field variable for 3 node triangular element.

$$J^{-1} = \frac{1}{|J|}\begin{bmatrix} y_{23} & -y_{13} \\ -x_{23} & x_{13} \end{bmatrix}.$$

3. Why polynomials are generally used a shape function.

* Differentiation & integration are quite easy.
* Accuracy of results can be improved by increasing the order of polynomial.
* Easy to formulate & Computerize the finite element equation.

4. List the properties of the global stiffness matrix.

* It is a symmetric matrix.
* Sum of elements in any column must be equal to zero.
* It has unstable elements.

5. List the characteristics of shape functions.

* It has unit value at one node point & zero value at the other nodal points.
* Sum of shape function is equal to one.

6. What do you mean by the terms: C^0, C^1 & C^n continuity?

* C^0 - Governing differential equation is quasi-harmonic, ϕ has to be continuous.

C^1 - Governing differential equation is bi-harmonic, ϕ as well as derivative has to be continuous inside & b/w elements.

C^n - Governing differential equation is polynomial.

7. Determine the element mass matrix for 1-D, dynamic structural analysis problem. Assume the two-node, linear element.

$$\Rightarrow [k]\{u\} = \{F\}.$$

$$\frac{AE}{l}\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}\begin{Bmatrix} u_1 \\ u_2 \end{Bmatrix} = \begin{Bmatrix} F_1 \\ F_2 \end{Bmatrix}.$$