
ST.ANNE'S

COLLEGE OF ENGINEERING AND TECHNOLOGY

ME6603 – FINITE ELEMENT ANALYSIS

Department: MECHANICAL

Semester : VI

PART –A

ME6603 – FINITE ELEMENT ANALYSIS

Two Marks Question and Answers.

UNIT-1 INTRODUCTION

1. What is meant by finite element?

A small units having definite shape of geometry and nodes is called finite element.

2. What is meant by finite element analysis? (Nov 2008)

Finite Element method is a numerical method for solving problems of engineering and mathematical physics. In the finite element method, instead of solving the problem for the entire body in one operation, we formulate the equations for each finite element and combine them to obtain the solution of the whole body.

3. **What is meant by node or joint?**

Each kind of finite element has a specific structural shape and is inter- connected with the adjacent element by nodal point or nodes. At the nodes, degrees of freedom are located. The forces will act only at nodes at any others place in the element.

4. **What are the types of boundary conditions? (Nov 2011)**

Primary boundary conditions

Secondary boundary conditions

5. **What is Rayleigh-Ritz method? (May 2012)**

It is integral approach method which is useful for solving complex structural problem, encountered in finite element analysis. This method is possible only if a suitable function is available.

6. What is Aspect ratio?

It is defined as the ratio of the largest dimension of the element to the smallest dimension. In many cases, as the aspect ratio increases the in accuracy of the solution increases. The conclusion of many researches is that the aspect ratio should be close to unity as possible.

7. **What is meant by degrees of freedom? (may2011)**

When the force or reaction act at nodal point node is subjected to deformation. The deformation includes displacement rotation, and or strains. These are collectively known as degrees of freedom

8. What is meant by discretization?

The art of subdividing a structure in to convenient number of smaller components is known as discretization. These smaller components are then put together. The process of uniting the various elements together is called assemblage

9. **What is meant by post processing?**

Analysis and evaluation of the solution result is referred to as post processing. Postprocessor computer program help the user to interpret the result by displaying them in graphical form.

10. **What are the methods are generally associated with the finite element analysis?**

- Force method
- Displacement or stiffness method.

11. Explain stiffness method.

Displacement or stiffness method, displacement of the nodes is considered as the unknown of the problem. Among them two approaches, displacement method is desirable.

12.. Explain Force Method?

In force Method, internal forces are considered as the unknowns of the problem

13. **Name the weighted residual method (Nov 2011)**

- Point collocation method
- Sub domain collocation method
- Lest squares method
- Galerkins method.

14.Name any four FEA software's.

ANSYS, NASTRAN, COSMOS, NISA, SAP , ABAQUS,etc.,

15. **What are the basic steps involved in the finite element modeling**

- Discretization of structure.
- Numbering of nodes

16. **List the types of nodes? (May 2012)**

- Exterior Nodes
- Interior Nodes

17. **What is interpolation functions? (May 2012)**

The function used to represent the behavior of the field variable with in an element are called interpolation functions.

18.Mntion the basic steps of Rayleigh-Ritz method? (May 2011)

The basic steps of Rayleigh-Ritz method are

- Assume a displacement field
- Evaluation of the total potential
- Set up and solve the system of equations

19. **Define Finite Element Analysis.**

The Finite Element Analysis is a computer aided mathematical technique that is used to obtain an approximate numerical solution to the fundamental differential and/or integral equations that predict the response of physical systems to external effects.

20. **List some of the applications of FEA.**

Applications: Structural Engineering, Aerospace Engineering, Automobile Engineering, Thermal applications, Acoustics, Flow Problems**,** Dynamics, Metal Forming , Medical & Dental applications, Soil mechanics etc.

21. **Define total potential energy.**

Total potential energy, π = Strain energy (U) + potential energy of the external forces (W)

22. **State the principle of minimum potential energy.**

Among all the displacement equations that satisfied internal compatibility and the boundary condition those that also satisfy the equation of equilibrium make the potential energy a minimum is a stable system.

UNIT II

ONE-DIMENSIONAL PROBLEMS

1.What is truss element? (Nov2012)

The truss elements are the part of a truss structure linked together by point joint which transmits only axial force to the element.

2. **Define the body force**

A body force is distributed force acting on every elemental volume of the body
Unit: Force per unit volume.
Example: Self weight due to gravity

3. Define traction force.

Traction force is defined as distributed force acting on the surface of the body.
Unit: Force per unit area.
Example: Frictional resistance, viscous drag, surface shear

4. **What do you mean by constitutive law?**

For a finite Element, the stress-strain relations are expressed as follows:
$\{\sigma\} = \{D\}\{e\}$
$\{\sigma\}$= Stress in N/m2

{D}=Stress-Strain relationship matrix
{e}=Strain (No Unit)

5. What is interpolation functions? (May 2012)

The function used to represent the behavior of the field variable with in an element are called interpolation functions.

6. **What is Global coordinates?**

The points in the entire structure are defined using coordinates system is known as global coordinate system.

7. What is natural coordinates?

A natural coordinate system is used to define any point inside the element by a set of dimensionless number whose magnitude never exceeds unity. This system is very useful in assembling of stiffness matrices.

8. **Why polynomials are generally used as shape function?**

Differentiation and integration of polynomial are quite easy.
The accuracy of the result can be improved by increasing the order of the polynomial. It is easy to formulate and computerize the finite element equations.

9. **State the properties of stiffness matrix**

- It is a symmetric matrix
- The sum of elements in any column must be equal to zero.
- It is an unstable element. So the determinant is equal to zero.

10. **State the assumptions made while finding the forces in a truss (Nov 2011)**

* All the members are pin jointed
* The truss is loaded only at the joints
* The self-weights of the members are neglected unless stated

11. When do we resort to 1D quadratic spar (bar) elements? (May 2011)

- Better Accuracy
- Representation of curved boundaries
- Faster Convergence

12. **What is meant by degrees of freedom?**

When the force or reaction act at nodal point node is subjected to deformation. The deformation includes displacement rotation, and or strains. These are collectively known as degrees of freedom

13. **What is meant by longitudinal vibration?**

When the particles of the shaft or disc moves parallel to the axis of the shaft, then the vibrations are known as longitudinal vibration.

14. What is meant by transverse vibration?

When the particles of the shaft or disc moves approximately perpendicular to the axis of the shaft, then the vibrations are known as transverse vibration.

15. **Write down the expression of longitudinal vibration of bar element.**

Free vibration equation for axial vibration of bar element is

$$[K]\{u\} = \omega^2[m]\{u\}$$

Where, u - displacement

[K] – stiffness matrix $[K] - \frac{AE}{L}\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$

ω – natural frequency $[m]$ – mass matrix

Lamped $[m] = \frac{\rho Al}{2}\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ Consistent $[m] = \frac{\rho AL}{2}\begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$

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16.Write down the expression of governing equation for free axial vibration of rod.

The governing equation for free axial vibration of rod is given by,

$$AE\ \frac{\partial^2 u}{\partial x^2} = \rho A\ \frac{\partial^2 u}{\partial t^2}$$

Where, E – Young's modulus,
A – cross section area
ρ– density

17. Write down the expression of governing equation for transverse vibration of beam

The governing equation for free transverse vibration of a beam is

$$EI\ \frac{\partial^4 v}{\partial x^4} + \rho A \frac{\partial^2 v}{\partial t^2} = 0$$

Where, E –Young's modulus
I –moment of inertia
ρ–density
A –cross sectional area

18. **Differentiate between global and local axes.**

Local axes are established in an element. Since it is in the element level, they change with the change in orientation of the element. The direction differs from element to element.

Global axes are defined for the entire system. They are same in direction for all the elements even though the elements are differently oriented.

19. **What is the difference between static and dynamic analysis?**

Static analysis: The solution of the problem does not vary with time is known as static analysis

Example: stress analysis on a beam

Dynamic analysis: The solution of the problem varies with time is known as dynamic analysis.

20. **State the need of Weak Formulation (Nov 2010)**

It reduces the continuity requirement on the trial function assumed in the solution. So it is referred to as the weak form. It is possible to have a wider choice of trial functions.

21. **Give the properties of shape function.**

- Sum of shape function is equal to one
- First derivative should be finite within the element
- Displacement should be continuous across the element boundary.
- The shape functions are always polynomials of the same type as the original interpolation equation.
- The accuracy of the result can be improved by increasing the order of the polynomial
- The shape function has unit value at its own nodal point and zero value at other nodal points.

UNIT III
TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS

1. What meant by plane stress analysis?

Plane stress is defined to be a state of stress in which the normal stress and shear stress directed perpendicular to the plane are assumed to be zero.

2. Define plane strain analysis. (Nov 2011)

Plane strain is defined to be state of strain normal to the xy plane and the shear strains are assumed to be zero.

4. How do you define two dimensional elements?(AU-NOV/DEC-2010)

Two dimensional elements are define by three or more nodes in a two dimensional plane. The basic element useful for two dimensional analysis is the triangular elements. The elements are analysed in two different axis as x and y axis. the two dimensional elements are used to analyse bar element, beam elemnt and the truss element. The structed analysis are carried out by means of governing equation and the displacement function with its boundary conditions.

5. What is CST element?

Three noded triangular element is known constant strain triangle (CST) which is shown in fig. it has six unknown displacement degree of freedom(u1 v1,u2 v2,u3 v3).the element is called CST because it has a constant strain throughout it.

Merits: Calculation of stiffness matrix is easier.

Demerits: The strain variation within the element is considered as constant. So, the results will be poor.

6. What is LST element?(AU-NOV/DEC-2011)

Linear strain triangular element(LST)

Six noded triangular element is known as linear strain triangular (LST). it has twelve unknown displacement degree of freedom. The displacement function for the element are quadratic instead of linear as in the CST.the nodes are arise in between the nodes in the CST(constant strain triangular elemnt. the elements are analysed and are a time consuming one.

7.Write a displacement function equation for CST element.

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

8. **Write down the stiffness equation for two dimensional CST element.**

Stiffness matrix, $[k] = [B]^T [D] At$ Where, [B]-strain –displacement matrix

[D]-Stress-strain matrix

A-area of the element

t-thickness of the element.

9. **Write a stain-displacement matrix for CST element. (AU-NOV/DEC-2013)**

Strain –displacement matrix for CST element is,

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

Where, A= area of the element

$q_1 = Y_2 - Y_3$; $q_2 = y_3 - y_1$; $q_3 = y_1 = y_2$

$r_1 = x3 - x2$; $r_2 = x_1 - x_3$; $r_3 = x_2 - x_1$

10. **Specify the applications of two –dimensional problems.**
Applications of two dimensional problems:
1. The plates under bi-axial loading, to find the load, stress, strain and displacement of the plates.
2. The bending of plates to find the load and moment acting on the beam and the displacement function.
3. The temperature distribution on the surface due to heat transfer to find the temperature distribution in the element.
11. **Define shape function. (AU MAY 2008)**
In finite element method, field variables with in an element are generally expressed by the
following approximate relation:
$\Phi(x, y) = N1(x, y)\ \phi1 + N2(x, y)\ \phi2 + N3(x,y)\ \phi3$
N1 N2&N3 are also called shape functions because they are used to express the geometry or shape of
the element.
$\phi1$ $\phi2$ & $\phi3$ are the values of the field variable at the nodes and N1 N2&N3 are the interpolation
functions

12.. If a displacement field in x direction is given by u: 2 x2 +4 y2 + 6xy. Determine the Strain
in x direction.
U: 2x2+4y2+6xy Strain, e $\partial u/\partial x = 4x+6y$
13. **Define variational formulation**
Variational formulation refers to the construction of a functional or a variational principle that is equivalent to the governing equations of the problem. It is nothing but the formation I which the governing equations are translated into equivalent weighted integral statements that are not necessarily equivalent to a variational principle.
14. **Write the Stress-strain relationship matrix [D] for plane stress problem and plane strain problem.**

$$[D] = \frac{E}{(1-\nu^2)}\begin{bmatrix} 1 & \nu & 0 \\ \nu & 1 & 0 \\ 0 & 0 & \frac{1-\nu}{2} \end{bmatrix}$$

$$[D]=\frac{E}{(1+\nu)(1-2\nu)}\begin{bmatrix}1-\nu & \nu & 0\\ \nu & 1-\nu & 0\\ 0 & 0 & \frac{1-2\nu}{2}\end{bmatrix}$$

15. **Write the Strain displacement relationship matrix [B] for CST element.**

[B]-strain-displacement matrix

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

$$q_1=(y_2-y_3)$$
$$q_2=(y_3-y_1)$$
$$q_3=(y_1-y_2)$$
$$r_1=(x_3-x_2):$$
$$r_2=(x_1-x_3):$$
$$r_3=(x_2-x_1):$$

16. **State the assumption made for pure torsion theory.**

- The material is Homogenous and perform/obey's the Hooke's law
- Twist is same for entire length
- strain and deformation is small

17. **What is higher order element ?**

For any element, if the interpolation polynomial is the order of two or more, that element is known as higher order elements

It is used to represent the curved boundaries

The number of elements are reduced when compared with straight edge elements to model geometry

18. **What are the four basic sets of elasticity equations?**

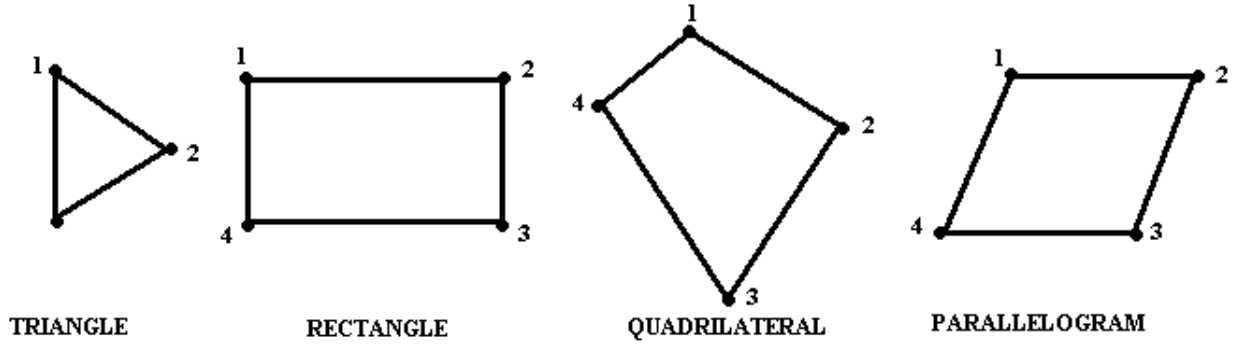
Elasticity equations are used for solving structural mechanical problems. There are four basics sets of elasticity equation. They are,

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

19. **Evaluate the area integrals for the three noded triangular element** $\int N_i N_j^2 N_k^3 dA$.

20. **Define two dimensional element.**

Two dimensional elements are defined by three or more nodes in a two dimensional plane (i.e., x, y plane). The basic element useful for two dimensional analysis is the triangular element.



UNIT IV

TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS

1. **What is axisymmetric element?**

Many three dimensional problem in engineering exhibit symmetry about an axis of rotation such type of problem are solved by special two dimensional element called the axisymmetric element

2. What are the conditions for a problem to be axisymmetric? (Apr 2010)

The condition to be axi-symmetrix is as follows

- The problem domain must be symmetric about the axis of revolution
- All boundary condition must be symmetric about the axis of revolution
- All loading condition must be symmetric about the axis of revolution

3. What are the four basic sets of elasticity equations? (May 2012)

Elasticity equations are used for solving structural mechanics problems. These equations must be satisfied if an exact solution to a structural mechanics problem is to be obtained. There are four basic sets of elasticity equations. They are:

- Strain- Displacement relationship equations
- Stress-Strain relationship equations
- Equilibrium equations
- Compatibility equations

4. What are the types of Non-Linearity ? (May 2012)

- Non-Linearity in material behavior from point to point
- Non-Linearity in loading deformation relation
- Geometric non-Linearity
- Change in boundary condition for different loading

5. What are higher order elements and why are they preferred? (April 2011)

- For any element, if the interpolation polynomial is the order of two or more, that element is known as higher order elements
- It is used to represent the curved boundaries
- The number of elements are reduced when compared with straight edge elements to model geometry

6. **Give four applications where axi-symmetric elements can be used? (April 2011)**

- Pressure Vessels
- Rocket Castings
- Cooling Towers
- Sub-Marine hulls
- Belleville spring

7. Write down the shape function for an axisymmetric triangular element

Shape function, $N_1 = \frac{\alpha_1 + \beta_1 r + \gamma_1 z}{2A}$

$$N_2 = \frac{\alpha_2 + \beta_2 r + \gamma_2 z}{2A}$$

$$N_3 = \frac{\alpha_3 + \beta_3 r + \gamma_3 z}{2A}$$

Where, $\alpha_1 = r_2 z_3 - r_3 z_2$

$$\beta_3 = z_1 - z_2 \qquad \alpha_2 = r_3 z_1 - r_1 z_3$$

$$\gamma_1 = r_3 - r_2 \qquad \alpha_3 = r_1 z_2 - r_2 z_1$$

$$\gamma_2 = r_1 - r_3 \qquad \beta_1 = z_2 - z_3$$

$$\gamma_3 = r_2 - r_1 \qquad \beta_2 = z_3 - z_1$$

8. Give the strain-displacement matrix equation for an axisymmetric triangular element.

$$[B]=\frac{1}{2A}\begin{bmatrix} \beta_1 & 0 & \beta_2 & 0 & \beta_3 & 0 \\ \frac{\alpha_1}{r}+\beta_1+\frac{\gamma_1 z}{r} & 0 & \frac{\alpha_2}{r}+\beta_2+\frac{\gamma_2 z}{r} & 0 & \frac{\alpha_3}{r}+\beta_3+\frac{\gamma_3 z}{r} & 0 \\ 0 & \gamma_1 & 0 & \gamma_2 & 0 & \gamma_3 \\ \gamma_1 & \beta_1 & \gamma_2 & \beta_2 & \gamma_3 & \beta_3 \end{bmatrix}$$

Where, co-ordinate, $r=\frac{r_1+r_2+r_3}{3}$

Co-ordinate, $z=\frac{z_1+z_2+z_3}{3}$

Where, $\alpha_1, \alpha_2\ \alpha_3, \gamma_1, \gamma_2\ \gamma_3, \beta_1, \beta_2, \beta_3$-co-ordinates

9. **Write down the stress-strain relationship matrix for an axisymmetric for an axisymmetric triangular element. (AU-APR/MAY-2012)**

Stress-strain relationship matrix, $[D]=\frac{E}{(1+v)(1-2v)}\begin{bmatrix} 1-v & v & v & 0 \\ v & 1-v & v & 0 \\ v & v & 1-v & 0 \\ 0 & 0 & 0 & \frac{1-2v}{2} \end{bmatrix}$

Where, E,-Young;s modulus
v-poisson's ratio.

10.Give stiffness matrix equation for an axisymmetric triangular element
Stiffness matrix,

$$[K]=2\Pi rA[B]T[D][B]$$

Where, co-ordinate

$r=\frac{r_1+r_2+r_3}{3}$

A-area of the triangular element matrix.

11.What are the ways in which a three dimensional problem can be reduced to a two dimension approach.

Reducing three dimensional element into two dimensional element:
(i) Plane stress; one dimensional is too small when compared to other two ic
(ii) dimensions.
(iii) Plane strain: one dimensional is too large when compared to other two dimensions
(iv) Axisymmetric: geometry about the axis.

12. **What are the advantages of shell elements?**

- Higher load carrying capacity.
- Lesser thickness and lesser dead load.
- Lesser support requirement.
- Larger useful space.
- Higher aesthetic value.

13. What are the types of shell elements?

- Flat shell element
- Solid shell element
- Curved shell element
- Degenerated shell element

14. Define shell element.

A shell element is curved surface, which by virtue of their shape can withstand both membrane and bending forces. A shell structure can take higher load s, membrane stresses and predominant, which is primarily caused due to in-plane forces.

15. Define plate element.

A plate is planar structure with a very small thickness in comparison to planar dimensions. The forces applied to a plate are perpendicular to the plane of the plate.

16. What are the assumptions for thin shell theory?

- Transverse normal stresses are neglected.
- All strain components are in the direction of the normal to the middle surface is zero.

17. What are the assumptions for thick plate element?

- The deflections of the plate are small.
- Stresses normal to the mid-surface are negligible.

UNIT-V
(2-marks Q & A)

1. Define natural co-ordinate systems

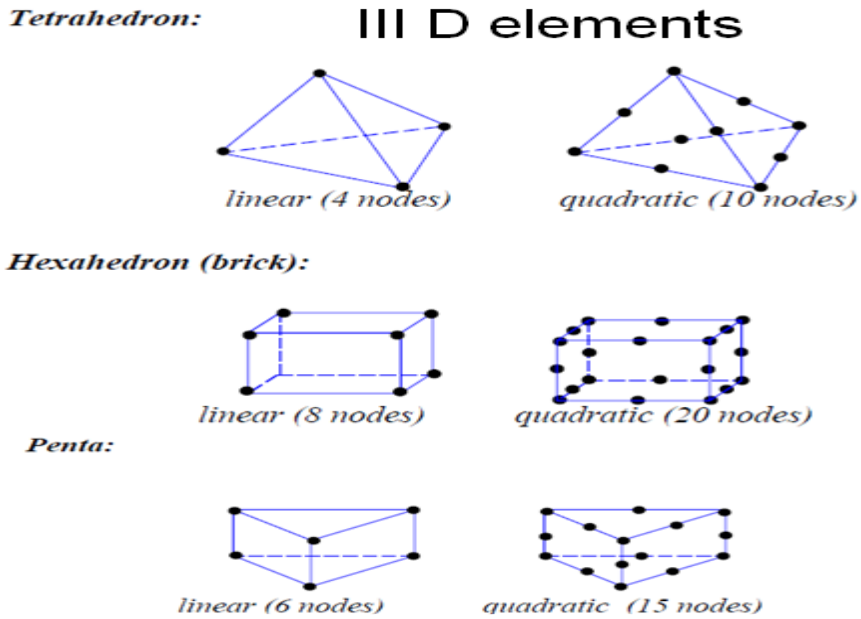
A Natural Co-ordinate system is a local co-ordinate system that permits the specification of a point within an element by a set of dimensionless numbers whose absolute magnitude never exceeds unity i.e. A I Dimensional element described by means of its two end vertices (x1 & x2) in Cartesian space is represented or mapped on to Natural co-ordinate space by the line whose end vertices □1 & □2 are given by –1 & +1 respectively.

2.List some of the advantages of natural co-ordinate systems

It is very convenient in constructing interpolation functions.

Integration involving Natural co-ordinate can be easily performed as the limits of the Integration is always from –1 to +1. This is in contrast to global co-ordinates where the limits of Integration may vary with the length of the element.

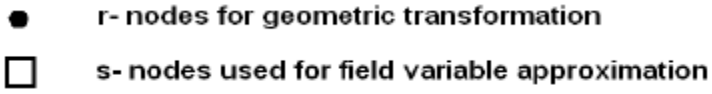
3. **List some 3D element.**



4. **What are the three classification of parametric elements?**

Depending upon the relationship between these two polynomials elements are classified into three categories as

1. sub parametric elements r < s
2. iso-paramatric elements r = s
3. super-parametric elements r > s



5. what is meant by Jacobian of Transformation

„Jacobian" of transformations from Cartesian space to natural co-ordinate space. It can be considered as the scale factor between the two co-ordinate systems.

6. **What is meant by Gauss Quadrature?**

Amongst the several schemes available for evaluating the area under the curve F(x) between two points the gauss quadrature method has proved to be most useful for isoparametric elements. As in isoparametric formulation, the limits of the integral are always from –1 to +1, the problem in gauss integration is to evaluate the integral.

7. **What is the purpose of isometric elements?**

It is difficult to represent the curved boundaries by straight edges finite elements. A large number of finite elements may be used to obtain reasonable resemblance

between original body and the assemblage. In order to overcome this drawback, isoparametric elements are used, for problems involving curved boundaries, a family of elements known as "isoparametric elements" are used.

8. **Write down the shape functions for 4 noded rectangular elements using natural co-ordinates system.**

Shape functions: $N_1 = \frac{1}{4}(1-\varepsilon)(1-\eta)$

$N_2 = \frac{1}{4}(1+\varepsilon)(1-\eta)$

$N_3 = \frac{1}{4}(1+\varepsilon)(1+\eta)$

$N4 = \frac{1}{4}(1-\varepsilon)(1+\eta)$

Where ε and η are natural co-ordinates.

9. **Write down the Jacobin matrix for four noded quadrilateral elements**

Jacobin matrix, $[J] = \begin{bmatrix} J_{11} & J_{12} \\ J_{21} & J_{22} \end{bmatrix}$

Where, $J_{11} = \frac{1}{4}[-(1-\eta)x_1 + (1-\eta)x_2 + (1+\eta)x_3 - (1-\eta)x_4]$

$J_{22} = \frac{1}{4}[-(1-\eta)y_1 + (1-\eta)y_2 + (1+\eta)y_3 - (1-\eta)y_4]$

$J_{21} = \frac{1}{4}[-(1-\varepsilon)x_1 + (1-\varepsilon)x_2 + (1+\varepsilon)x_3 - (1-\varepsilon)x_4]$

$J_{22} = \frac{1}{4}[-(1-\varepsilon)y_1 + (1-\varepsilon)y_2 + (1+\varepsilon)y_3 - (1-\varepsilon)y_4]$

Where ε and η are natural co-ordinates.

$x_1, x_2, x_3, x_4, y1, y_2, y_3, y_4$ are Cartesian co-ordinates.

10.Write down the stiffness equation for four noded isoparametric quadrilateral element.

Stiffness matrix, $[K] = t\int_{-1}^{1}\int_{-1}^{1}[B]^T[D][B]X|J|X\partial\varepsilon X\partial\eta$

Where, t= thickness of the element

$|J|$ =determinant of the Jacobin

ε, η =natural coordinates.

[B]=strain-displacement matrix.

[D]=stress-strain relationship matrix.

11. **Write down the element force vector equation for four noded quadrilateral elements.**

Force vector, $\{F\}_e = [N]^T \begin{Bmatrix} F_x \\ F_y \end{Bmatrix}$

Where, N-is the shape function

F_x-is a load or force on x-direction

F_y-is a force on y-direction.

12. **Define super parametric element.**

If the number of nodes used for defining the geometry is more than number of nodes used for defining the displacement, then it is known as super parametric element. The super parametric elements are quadratic element which has the many number of nodes to get the nearest possible solution for the problem. The defined structure or the boundary of the defined problem.

13. What is meant by sub-parametric element?

If the number of nodes used for defining the geometry is less than number of nodes used for defining the displacement, then it is known as sub-parametric element. Sub parametric elements are simple element which are divided when the elements are giving solution possible functions. The functions are the difference between the original value and the find value from the problem.

14. **What is meant by isoparametric element? (AU-APR/MAY-2014)**

If the number of nodes used for defining the geometry is same as number of nodes used for defining the displacement, the n it is known as isoparametric element. Isoparametric elements of simple shapes expressed in natural coordinate system known as master elements are the transformed shapes of some arbitrary curved sided actual elements expressed in Cartesian coordinate system.

15.Write short note on isoparametric element formulation. (AU-APR/MAY-2011)

Isometric formulation:

The principal concept of isoparametric finite element is to express the element coordinates and element displacements in the form of interpolations using the natural coordinate system of the element. These isoparametric elements of simple shapes expressed in natural coordinate system known as master elements are the transformed shapes of some arbitrary curved sided actual elements expressed in Cartesian coordinate system.

iso-parametric elements – structural mechanics applications in 2-dimensions

16. **Differentiate isoparametric, super parametric and sub parametric elements.**

Isoparametric:

For an element if the geometry and field variables are described by the same shape function of equal order.

Super parametric:
If the order of the shape functions for describing the geometry is more than that of the describing field variable.
Parametric element:
If the order of the shape function describing the geometry is less than that for describing field variable.

17. Define higher order element. (AU-APR/MAY-2010)

Higher order element:
For any element if the interpolation polynomial is of order two or more the element is known as higher order element. In higher order element the field variable variation is non-linear. Also it may be a complex or multiplex element. In higher order element some secondary nodes are produced in addition to the primary nodes in order to match the number of nodal degrees of freedom with the number of polynomial coefficients in the polynomial interpolation.

18. Write in brief about gauss – quadrature method.

Gauss-quadrature method:
Gauss quadrature is thesimple integration method for the definite integrals. It includes some specific functions like weight functions and some sampling points called Gauss-point through which the approximation method has been carried out.
For example

$$I = \int_a^b f(x)dx$$

19. **Define frequency of vibration.**

It is the number of cycles described in one second. Unit is HZ

20. Define damping ratio.

It is define as the ratio of actual damping coefficient (c) to the critical damping coefficient (cc)
Damping ratio $\varepsilon = 0$

21. What is meant by longitudinal vibration?

When the particles of the shaft or disc moves parallel to the axis of the shaft, then the vibrations are known as longitudinal vibration.

22. What is meant by transverse vibration?

When the particles of the shaft or disc moves approximately perpendicular to the axis of the shaft, then the vibrations are known as transverse vibration.

23. Define magnification factor.

The ratio of the maximum displacement of the forced vibration (xmax) to the static deflecyion under the static force (x0) is known as magnification factor.

24.State the principle of superposition.

It states that for linear system, the individual responses to several disturbances or driving function can be superposed on each other to obtain the total response of the system.

25. Define resonance.

When the frequency of external force is equal to the natural frequency of a vibration body, the amplitude of vibration becomes excessively large. This phenomenon is known as resonance.

26. Define Dynamic Analysis.

When the inertia effect due to the mass of the component is also considered in addition to the externally applied load, then the analysis is called dynamic analysis

27.**State the two difference between direct and iterative methods for solving system of equation.**

	Direct Method	Iterative Method
(i)	It given exact value	It gives only approximate solution
(ii)	Simple, take less time	Time consuming and labourious
(iii)	Determine all the roots at the same time	Determine only one root at the time

28. **What are methods used for solving transient vibration problem?**

There are two methods for solving transient vibration problem. They are:

- ✓ Mode superposition method
- ✓ Direct integration method
