INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

DEFINITIONS AND TERMINOLOGY QUESTION BANK

Course Name	:	**FINITE ELEMENT MODELLING**
Course Code	:	**AME014**
Program	:	**B. Tech**
Semester	:	**VI**
Branch	:	**Mechanical Engineering**
Section	:	**A & B**
Academic Year	:	**2019– 2020**
Course Faculty	:	**Mrs. V. Prasanna, Assistant Professor, ME** **Mr. B.D.Y. Sunil, Associate Professor, ME**

OBJECTIVES:

I	To help students to consider in depth the terminology and nomenclature used in the syllabus.
II	To focus on the meaning of new words / terminology/nomenclature

DEFINITIONS AND TERMINOLOGYQUESTION BANK

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
1	Elucidte the rate at which heat enters from the face of the element.	The rate at which heat enters from the face of the element is given as: $qx = -kA(\frac{\partial T}{\partial x})$	Remember	CO 1	CLO1	AME014.01
2	Express a bar element under axial load write the element equation in matrix form.	The element equations in matrix form can be expressed as: $\begin{bmatrix} k11 & k12 \\ k21 & k22 \end{bmatrix} \begin{bmatrix} q1 \\ q2 \end{bmatrix} \begin{bmatrix} F1 \\ F2 \end{bmatrix}$	Understand	CO 1	CLO2	AME014.02
3	Calculate 1D solid bar element under axial load, given AE as axial load?	The 1D solid bar element under axial load can be expressed as: $\frac{\partial}{\partial x} AE \left(\frac{\partial u}{\partial x}\right) 0=$	Remember	CO 1	CLO1	AME014.01
4	List out the methods are generally associated with the finite element analysis?	The following two methods are generally associated with the finite element analysis. They are 1. Force method. 2. Displacement or stiffness method	Remember	CO 1	CLO1	AME014.01

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
5	Explain force method and stiffness method?	In force method, internal forces are considered as the unknowns of the problem. In displacement or stiffness method, displacement of the node is considered as the problem. Among them two approaches, the displacement method is desirable.	Remember	CO 1	CLO1	AME014.01
6	State polynomial type of interpolation functions are mostly used in FEM?	The polynomial type of interpolation functions is mostly used due to the following reasons: 1. It is easy to formulate and computerize the finite element equations. 2. It is easy to perform differentiation or integration. 3. The accuracy of the results can be improved by increasing the order of the polynomial.	Understand	CO 1	CLO3	AME014.03
7	List out the variational methods.	The variational methods in FEM are: 1.Ritz method. 2. Rayleigh – Ritz method	Understand	CO 1	CLO2	AME014.02
8	List outthe weighted residual	1.Point collocation method. 2. Subdomain collocation method. 3. Least square method 4. Galerkin's method	Understand	CO 1	CLO2	AME014.02
9	State post processing?	Analysis and evaluation of the solution results is referred to as post processing. Post processor computer programs help the user to interpret the results by displaying them in graphical form.	Remember	CO 1	CLO1	AME014.01
10	State assemblage mean?	The art of subdividing a structure into a 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.	Understand	CO 1	CLO2	AME014.02
11	Define DOF?	When the force or reaction acts at nodal point, node is subjected to deformation. The deformation includes displacement, rotations, and/or strains. These are collectively known as degrees of freedom (DOF).	Remember	CO 1	CLO2	AME014.02
12	State finite element analysis?	Finite element method is a numerical method for solving problems of engineering mathematical physics.	Understand	CO 1	CLO3	AME014.03
13	State finite element?	A small unit having definite shape of geometry and nodes is called finite element.	Remember	CO 1	CLO3	AME014.03
14	State node or	Each kind of finite element has a specific structural shape and is interconnected with the adjacent elements by nodal points or nodes.	Remember	CO 1	CLO3	AME014.03

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
	Joint?	At the nodes, degrees of freedom are located. The forces will act only at nodes and not at any other place in the element.				
15	Define discretization?	Discretization is the basis of finite element method. The art of subdividing a structure into a convenient number of smaller components is known as discretization.	Remember	CO 1	CLO3	AME014.03
16	List out types of boundary conditions?	There are two types of boundary conditions, they are Primary boundary condition. Secondary boundary condition.	Understand	CO 1	CLO4	AME014.04
17	Classify three phases of finite element method?	The three phases are 1. Preprocessing 2. Analysis 3.Postprocessing	Understand	CO 1	CLO4	AME014.04
18	Define structural and non-structural problem?	Structural problem: In structural problems, displacement at each nodal point is obtained. By using these displacement solutions, stress and strain in each element can be calculated. Non-Structural problem: In nonstructural problem, temperatures or fluid pressure at each nodal point is obtained. By using these values, Properties such as heat flow, fluid flow, etc., for each element can be calculated.	Remember	CO 1	CLO4	AME014.04

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
1	Name the four FEA software's.	The FEA software's are: 1. ANSYS 2. NASTRAN 3. COSMOS 4. NISA	Remember	CO 2	CLO6	AME014.06
2	Define normal strain in axial direction.	The normal strain in axial direction is given as: $\epsilon xx = \frac{\partial u}{\partial x}$	Remember	CO 2	CLO6	AME014.06
3	Write the shear strain equation.	Shear strain is given by: $\epsilon xy = \frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}$	Remember	CO 2	CLO6	AME014.06
4	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	Understand	CO 2	CLO8	AME014.08

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
		direction for all the elements even though the elements are differently oriented.				
5	Write the stress strain relation.	The stress strain relation is given by: $\sigma xx = E\ (\epsilon xx - \epsilon xx0)$	Remember	CO 2	CLO6	AME014.06
6	What are the types of loading acting on the structure?	There are three types of loading acting on the body. They are: 1. Body force 2. Traction force 3. Point load	Understand	CO 2	CLO8	AME014.08
7	What is truss?	A truss is defined as a structure, made up of several bars, riveted or welded together.	Remember	CO 2	CLO6	AME014.06
8	Write the transformation matrix for a space truss element.	For a space truss element, the transformation matrix is given by: $[\lambda] = \begin{bmatrix} lij & mij & nij & 0 & 0 & 0 \\ 0 & 0 & 0 & lij & mij & nij \end{bmatrix}$	Remember	CO 2	CLO6	AME014.06
9	How do you calculate the size of the global stiffness matrix?	Global stiffness matrix size = Number of nodes X Degrees of freedom per node	Remember	CO 2	CLO6	AME014.06
10	What is non-homogeneous form?	When the specified values of dependent variables are non-zero, the boundary conditions said to be non-homogeneous.	Remember	CO 2	CLO6	AME014.06
11	What is homogeneous form?	When the specified values of dependent variables is zero, the boundary condition are said to be homogeneous.	Remember	CO 2	CLO6	AME014.06
12	What is mean by beam?	Beams are slender members used for supporting transverse loading.	Understand	CO 2	CLO8	AME014.08
13	How the hermit shape functions are used in FEA?	In Finite Element Method (FEM), Hermite interpolation functions are used for interpolation of dependent variable and its derivative.	Understand	CO 2	CLO8	AME014.08
14	What is aspect ratio?	Aspect ratio 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 inaccuracy of the solution increases. The conclusion of many researches is that the aspect ratio should be close to unity as possible.	Remember	CO 2	CLO6	AME014.06
15	What is truss element?	The truss elements are the part of a truss structure linked together by point joints, which transmit only axial force to the element.	Understand	CO 2	CLO8	AME014.08
16	List the two advantages of post processing?	1. Required result can be obtained in graphical form. 2. Contour diagrams can be used to understand the solution easily and quickly.	Understand	CO 2	CLO8	AME014.08

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
17	What are 'h' versions of finite element method?	H version and p versions are used to improve the accuracy of the finite element method. In h versions, the order of polynomial approximation for all elements is kept constant and the number of elements is increased.	Understand	CO 2	CLO8	AME014.08
18	What is p versions of finite element method?	In p version, the number of elements is maintained constant and the order of polynomial approximation of element is increased.	Understand	CO 2	CLO8	AME014.08
19	During discretization, mention the places where it is necessary to place a node	The following places are necessary to place a node during discretization process. 1. Concentrated load-acting point. 2. Cross section changing point 3. Different material inter-junction point 4. Sudden change in load point.	Remember	CO 2	CLO6	AME014.06

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
1	Write the internal equilibrium equation in the x-direction for a 3D element.	The internal equilibrium equation in the x-direction for a 3D element is given by: $\frac{\partial \sigma xx}{\partial x} + \frac{\partial \sigma xy}{\partial y} + \frac{\partial \sigma zx}{\partial z} + \emptyset x = 0$	Understand	CO 3	CLO10	AME014.10
2	Write the internal equilibrium equation in the y-direction for a 3D element.	The internal equilibrium equation in the y-direction for a 3D element is given by: $\frac{\partial \sigma xy}{\partial x} + \frac{\partial \sigma yy}{\partial y} + \frac{\partial \sigma yz}{\partial z} + \emptyset y = 0$	Understand	CO 3	CLO10	AME014.10
3	Write the internal equilibrium equation in the z-direction for a 3D element.	The internal equilibrium equation in the z-direction for a 3D element is given by: $\frac{\partial \sigma zx}{\partial x} + \frac{\partial \sigma yz}{\partial y} + \frac{\partial \sigma zz}{\partial z} + \emptyset z = 0$	Understand	CO 3	CLO10	AME014.10
4	What are the ways by which a 3D problem can be reduced to a 2D problem?	By using axisymmetric concept, the 3D problems like stress analysis of piston, storage tanks, pressure vessels etc, can be reduced to 2D problems. Sometimes, a plane stress and plane strain concepts also help us to analyse the 3D problems as 2D problems.	Understand	CO 3	CLO10	AME014.10
5	vector variable problem?	In vector variable problem the field variable is described by its magnitude and direction of action in order to complete information and for further process.	Understand	CO 3	CLO10	AME014.10

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
6	Justify why 3 noded triangular element called as CST?	In a 3-noded triangular element, for a specific loading, the stress developed is assumed constant throughout the element. As per Hooke's law, □ = E× ϵ. Since stress is constant and modulus of elasticity is also constant due to material property, the strain is constant throughout the element and hence called as constant strain triangular (CST) element.	Remember	CO 3	CLO11	AME014.11
7	Define plane stress.	A state of plane stress is said to exist when the elastic body is very thin and there is no load applied in the coordinate direction parallel to the thickness.	Remember	CO 3	CLO11	AME014.11
8	Explain 2D scalar variable problem?	If the geometry and material properties of any element are described by two spatial coordinates, then that element is referred as two-dimensional finite element and, in a problem, containing that element if the measured parameter is having only one quantity (i.e., magnitude only) and not having direction of application, then it is referred as 2D scalar variable problem.	Remember	CO 3	CLO11	AME014.11
9	Define the ways by which a 3D problem can be reduced to a 2D problem?	By using axisymmetric concept, the 3D problems like stress analysis of piston, storage tanks, pressure vessels etc., can be reduced to 2D problems. Sometimes, a plane stress and plane strain concepts also help us to analyse the 3D problems as 2D problems.	Remember	CO 3	CLO11	AME014.11
10	Define is a vector variable problem?	In vector variable problem the field variable is described by its magnitude and direction of action in order to complete information and for further process. Example: structural problem.	Remember	CO 3	CLO11	AME014.11
11	Explain triangular element called as CST?	In a 3-noded triangular element, for a specific loading, the stress developed is assumed constant throughout the element. As per Hooke's law, stress = modulus of elasticity × strain. Since stress is constant and modulus of elasticity is also constant due to material property, the strain is constant throughout the element and hence called as constant strain triangular (CST) element.	Remember	CO 3	CLO11	AME014.11

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
12	Define plane stress.	A state of plane stress is said to exist when the elastic body is very thin and there is no load applied in the coordinate direction parallel to the thickness.	Understand	CO 3	CLO12	AME014.12
13	Give an example for plane stress.	A ring press – fitted on a shaft is a plane stress problem. In plane stress problem, σ_z, τ_{yz} and τ_{zx} are zero.	Understand	CO 3	CLO12	AME014.12
14	Define plane strain.	A state of plane strain occurs in members that are not free to expand in the direction perpendicular to the plane of applied loads.	Understand	CO 3	CLO12	AME014.12
15	Give an example for plane strain.	In a long body of uniform cross-section, subjected to transverse loading along its length, a small thickness in the loaded area can be treated as plane strain problem. In plane strain problem, ϵ_z, γ_{yz} and γ_{zx} are zero.	Understand	CO 3	CLO12	AME014.12
16	Define axisymmetric solid?	In some 3D solids like cylinder, fly-wheel, turbine discs etc., the material content is symmetric with respect to their axes. Hence, the stress developed, displacement produced etc., are considered as symmetric. Such solids are known as axisymmetric solids.	Remember	CO 3	CLO11	AME014.11
17	State the conditions to be satisfied in order to use axisymmetric elements.	The required conditions to be satisfied are such that the material content, loading conditions, boundary conditions and material properties like strength, nature etc., should be symmetric with respect to axis of revolution.	Remember	CO 3	CLO11	AME014.11
18	Euclidate QST element?	Ten nodded triangular elements are known as Quadratic strain triangle. It is also called as cubic displacement triangle.	Remember	CO 3	CLO11	AME014.11

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
1	For an inviscid fluid with potential function $\emptyset(x)$, write the 1D fluid flow.	For a inviscid fluid with potential function $\emptyset(x)$, the 1D fluid flow is expressed as: $\frac{\partial}{\partial x}\left(\rho A \frac{d\emptyset}{dx}\right) = 0$	Remember	CO 4	CLO13	AME014.13
2	Write the energy balance equation for the element for dt	The energy balance equation can be written as: $qxdt + \dot{q}Adxdt = qx + dxdt + c\rho$	Remember	CO 4	CLO13	AME014.13

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
3	State Fourier's law.	If $\dot{q}$ is zero in energy equation, we get the Fourier equation, represented as: $\frac{\partial}{\partial x}\left(kA\frac{\partial T}{\partial x}\right) = c\rho\frac{\partial T}{\partial t}$	Remember	CO 4	CLO13	AME014.13
4	Calculate Poisson's equation.	If the system is in steady state, then the energy equation can be reduced to: $\frac{\partial}{\partial x}\left(kA\frac{\partial T}{\partial x}\right) + \dot{q}A = 0$ This is the Poisson's equation.	Remember	CO 4	CLO13	AME014.13
5	Describe Laplace equation.	If the heat source is zero, then the energy equation is reduced to: $\frac{\partial}{\partial x}\left(kA\frac{\partial T}{\partial x}\right) = 0$	Remember	CO 4	CLO13	AME014.13
6	Estimate fins or extended surfaces.	It is possible to increase the heat transfer rate by increasing the surface of heat transfer. The surfaces used for increasing heat transfer are called extended surfaces sometimes known as fins.	Understand	CO 4	CLO13	AME014.13
7	Euclidate dimensional analysis?	Dimensional analysis is a mathematical method which makes use of the study of the dimensions for solving several engineering problems. This method can be applied to all types of fluid resistance, heat flow problems in fluid mechanics and thermodynamics.	Remember	CO 4	CLO13	AME014.13
8	Describe the various boundary conditions to be considered in heat transfer analysis?	The boundary conditions are mainly of three kinds: specified temperature, specified heat flux and convection.	Understand	CO 4	CLO14	AME014.14
9	State energy balance for an element in dt time?	The energy balance for the element for a small time dt is given by the sum of heat inflow and heat generated by internal sources in time dt is equal to the sum of heat outflow in time dt and change in internal energy in time dt.	Understand	CO 4	CLO14	AME014.14
10	Euclidate Fourier law?	If the heat source is zero, we obtain Fourier law from the energy balance equation.	Remember	CO 4	CLO13	AME014.13
11	State Poissons equation?	If the system attains steady state condition the energy balance equation becomes Poissons equation.	Remember	CO 4	CLO13	AME014.13
12	Describe Laplace equation?	If the system attains steady state and the heat source is zero, the resulting equation from the energy balance is said to be Laplace equation.	Understand	CO 4	CLO14	AME014.14

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
13	Estimate the analogy of conductance matrix with respect to structural matrix equation KQ=F?	The conducting matrix from the heat transfer is given by $K_e=KA_e/l$ $\begin{matrix}1 & -1\\ -1 & 1\end{matrix}$	Remember	CO 4	CLO13	AME014.13
14	Define Newtons law of convection?	The Newtonian law of convection is given as $q = h(T_s-T_\infty)$	Remember	CO 4	CLO13	AME014.13
15	Discuss the relation between Stefan boltzman constant and radiation heat flux?	The relation between Stefan boltzman constant and radiation heat flux is given as $q = \sigma T^4$	Understand	CO 4	CLO14	AME014.14
16	Define 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.	Remember	CO 4	CLO13	AME014.13
17	Give example for non-essential boundary conditions.	The natural boundary conditions are bending moment, shear force.	Remember	CO 4	CLO13	AME014.13
18	Euclidate simple natural coordinate?	A simple natural coordinate is one whose value between -1 and 1.	Remember	CO 4	CLO13	AME014.13
19	Define Thermal conductivity.	Thermal conductivity is defined as the ability of a substance to conduct heat.	Remember	CO 4	CLO13	AME014.13
20	Define conduction?	Heat conduction is a mechanism of heat transfer from a region of high temperature to a region of low temperature with in a medium (Solid, liquid or Gases) or different medium in direct physical contact.	Remember	CO 4	CLO13	AME014.13
21	Define convection.	Convection is a process of heat transfer that will occur between solid surface and a fluid medium when they are at different temperatures. Convection is possible only in the presence of fluid medium.	Understand	CO 4	CLO14	AME014.14

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
1	Euclidate are types of vibrations?	According to the actuating force 1. Free or natural vibrations 2. Forced vibrations 3. Damped vibrations 4. Undamped vibrations	Remember	CO 5	CLO16	AME014.16

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
		According to motion of system with respect to axis 1. Longitudinal vibrations 2. Transverse vibrations 3. Torsional vibrations				
2	Describe the locations at which nodes can be positioned during discretization?	1. The point of change of cross section 2. The point of concentrated load acting 3. The point of different material connection 4. The point of load changing.	Remember	CO 5	CLO16	AME014.16
3	Define - (a) time period (b) frequency (c) amplitude with respect to FEM.	Time period is defined as the time taken by a motion to repeat itself. That is, it is the time required for one complete motion, usually measured in seconds. Frequency is defined as the number of cycles completed in one second. It is expressed in hertz (Hz). It is the reciprocal of time period. Amplitude is defined as the maximum displacement of a vibrating body from the mean position.	Remember	CO 5	CLO16	AME014.16
4	Define - free vibration and forced vibration.	When a system oscillates only under an initial disturbance with no external force acting after the initial disturbance, that system is said to undergo free vibration. If a system is subjected to an external force, the resulting vibration is known as forced vibration.	Understand	CO 5	CLO17	AME014.17
5	Euclidate is static analysis?	The solution of the problem does not vary with time is known as static analysis Example: stress analysis on a beam	Understand	CO 5	CLO17	AME014.17
6	Define dynamic analysis?	The solution of the problem varies with time is known as dynamic analysis Example: vibration analysis problem.	Understand	CO 5	CLO17	AME014.17
7	Define 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.	Remember	CO 5	CLO16	AME014.16
8	Define essential boundary condition?	Primary boundary condition or EBC, Boundary condition which in terms of field variable.	Understand	CO 5	CLO17	AME014.17
9	State non-homogeneous form?	Non-homogeneous form: When the specified values of dependent variables are non-zero, the boundary condition.	Understand	CO 5	CLO17	AME014.17

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
10	State what is homogeneous form?	When the specified values of dependent variables is zero, the boundary condition are said to be homogeneous.	Remember	CO 5	CLO16	AME014.16
11	State initial value problem.	An initial value problem is one in which the dependent variable and possibly is derivatives are specified initially.	Understand	CO 5	CLO17	AME014.17
12	Describe Boundary value problem.	A differential equation is said to describe a boundary value problem if the dependent variable and its derivatives are required to take specified values on the boundary.	Understand	CO 5	CLO17	AME014.17
13	Validate the governing equation.	The governing equation is given as: $\frac{d}{dx}EA\left(\frac{du}{dx}\right)+\rho A=0$	Understand	CO 5	CLO17	AME014.17
14	Describe the 'h' and 'p' versions of finite element method?	It is used to improve the accuracy of the finite element method. In h version, the order of polynomial approximation for all elements is kept constant and the numbers of elements are increased. In p version, the numbers of elements are maintained constant and the order of polynomial approximation of element is increased.	Remember	CO 5	CLO16	AME014.16
15	Contrast free vibration and forced vibration	When a system oscillates only under an initial disturbance with no external force acting after the initial disturbance, that system is said to undergo free vibration. If a system is subjected to an external force, the resulting vibration is known as forced vibration.	Remember	CO 5	CLO16	AME014.16

Signature of the Faculty Signature **HOD, ME**