INSTITUTEOFAERONAUTICALENGINEERING

(Autonomous)

Dundigal, Hyderabad-500043

AERONAUTICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**FINITE ELEMENT METHODS**				
Course Code	AAE009				
Programme	B.Tech				
Semester	V	AE			
Course Type	Core				
Regulation	**IARE - R16**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Mr. S Devaraj, Assistant Professor				
Course Faculty	Mr. S Devaraj, Assistant Professor Ms. Ch RaghaLeena, Assistant Professor				

COURSE OBJECTIVES:

The course should enable the students to:	
I	Introduce basic concepts of finite element methods including domain discretization, polynomial interpolation and application of boundary conditions.
II	Understand the theoretical basics of governing equations and convergence criteria of finite element method.
III	Develop of mathematical model for physical problems and concept of discretization of continuum.
IV	Discuss the accurate Finite Element Solutions for the various field problems.
V	Use the commercial Finite Element packages to build Finite Element models and solve a selected range of engineering problems

COURSE OUTCOMES (COs):

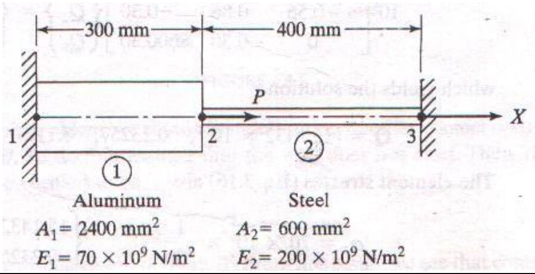
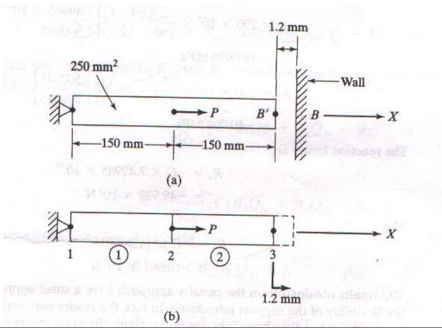
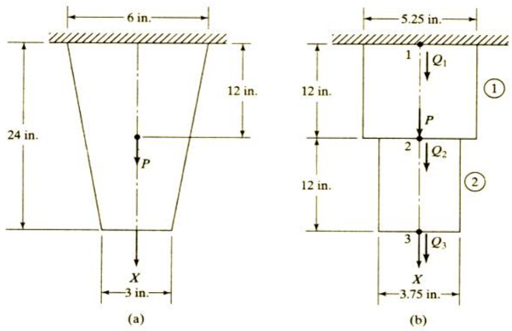
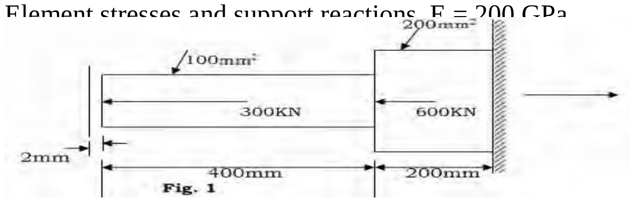
CO 1	Describe the concept of FEM and difference between the FEM with other methods and problems based on 1-D bar elements and shape functions.
CO 2	Derive elemental properties and shape functions for truss and beam elements and related problems.
CO 3	Understand the concept deriving the elemental matrix and solving the basic problems of CST and axi-symmetric solids.
CO 4	Explore the concept of steady state heat transfer in fin and composite slab.
CO 5	Understand the concept of consistent and lumped mass models and slove the dynamic analysis of all types of elements.

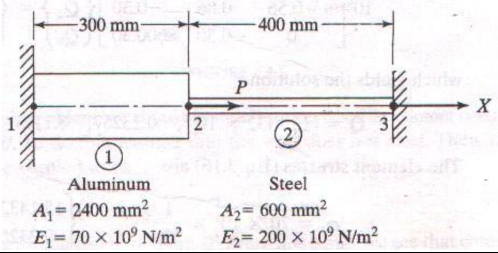
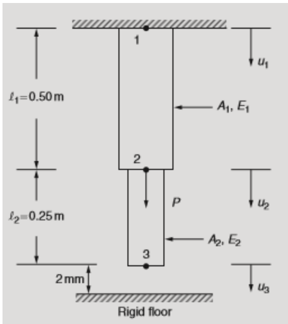
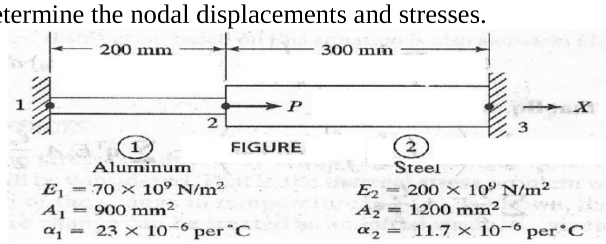
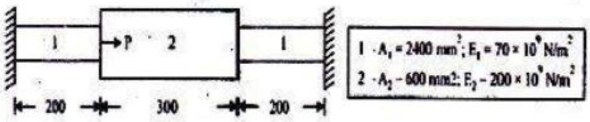
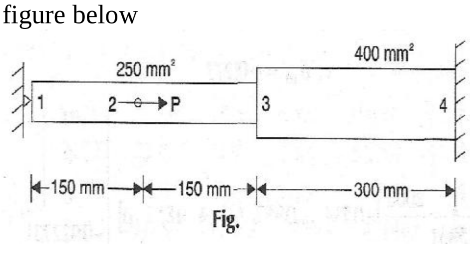
COURSE LEARNING OUTCOMES (CLOs):

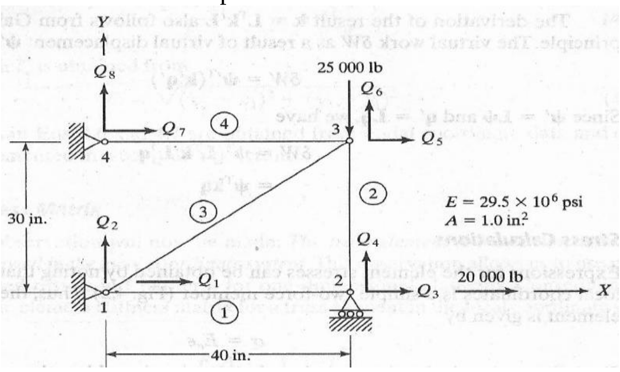
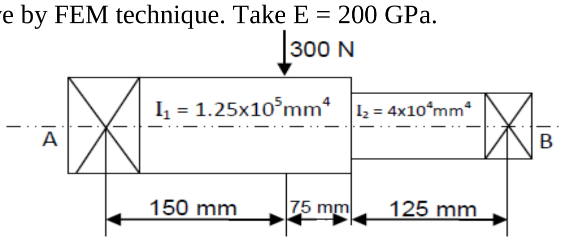
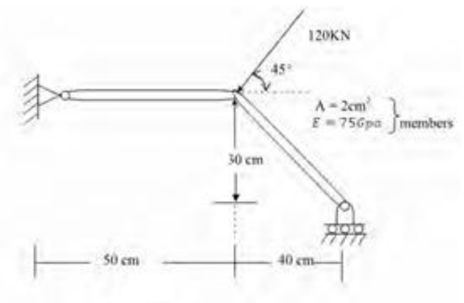
AAE009.01	Describe the basic concepts of FEM and steps involved in it.
AAE009.02	Understand the difference between the FEM and Other methods.
AAE009.03	Understand the stress-strain relation for 2-D and their field problem.
AAE009.04	Understand the concepts of shape functions for one dimensional and quadratic elements, stiffness matrix and boundary conditions.
AAE009.05	Apply numerical methods for solving one dimensional bar problems.
AAE009.06	Derive the elemental property matrix for beam and bar elements.
AAE009.07	Solve the equations of truss and beam elements.
AAE009.08	Understand the concepts of shape functions for beam element.
AAE009.09	Apply the numerical methods for solving truss and beam problems.
AAE009.10	Derive the element stiffness matrices for triangular elements and axi- symmetric solids and estimate the load vector and stresses.
AAE009.11	Formulate simple and complex problems into finite elements and solve structural and thermal problems.
AAE009.12	Understand the concept of CST and LST and their shape functions.
AAE009.13	Understand the concepts of steady state heat transfer analysis for one dimensional slab, fin and thin plate.
AAE009.14	Derive the stiffness matrix for for fin element.
AAE009.15	Solve the steady state heat transfer problems for fin and composite slab.
AAE009.16	Understand the concepts of mass and spring system and derive the equations for various structural problems
AAE009.17	Understand the concept of dynamic analysis for all types of elements.
AAE009.18	Calculate the mass matrices, Eigen values, Eigen vectors, natural frequency and mode shapes for dynamic problems.

TUTORIAL QUESTION BANK

UNIT- I				
INTRODUCTION				
Part - A (Short Answer Questions)				
S No	**QUESTIONS**	**Blooms Taxonomy Level**	**Course Outcomes**	**Course Learning Outcomes (CLOs)**
1	Explain any two characteristics of shape functions.	Remember	CO 1	AAE009.04
2	What is degree of freedom and boundary conditions?	Understand	CO 1	AAE009.05
3	Give the expression for shape functions of a linear element.	Remember	CO 1	AAE009.04
4	Specify some applications of finite element methods	Remember	CO 1	AAE009.02
5	Name the different methods used for solving problems in FEM	Remember	CO 1	AAE009.02
6	Draw the shape functions of quadratic element and linear element	Remember	CO 1	AAE009.04
7	What is the element stiffness matrix for a quadratic element	Remember	CO 1	AAE009.04
8	Write the expressions for stress strain relationship for 2D elastic problems	Remember	CO 1	AAE009.03
9	What is the stiffness matrix for one dimensional element?	Remember	CO 1	AAE009.03
10	Discuss different types of elements	Remember	CO 1	AAE009.05
Part - B (Long Answer Questions)				
1	Explain the concept of FEM briefly and outline the steps involved in FEM.	Remember	CO 1	AAE009.01
2	What is the difference between the plane stress and plane strain condition?	Remember	CO 1	AAE009.03
3	Define principle of virtual work. Describe the FEM formulation for 1D bar element.	Understand	CO 1	AAE009.05
4	Derive element stiffness matrix and load vector for linear element using potential energy approach.	Understand	CO 1	AAE009.04
5	Compare finite element method with finite difference method.	Remember	CO 1	AAE009.02
6	Explain the criteria for nodal selection for structural elements.	Remember	CO 1	AAE009.01

7	Briefly discuss the discretization process and types of elements used for discretization.	Remember	CO 1	AAE009.01
8	Explain the equilibrium state of the system, when the system is subjected to different types of loads and explain the stress and equilibrium relations	Remember	CO 1	AAE009.03
9	Derive stress strain relationships for 2D elastic problems.	Understand	CO 1	AAE009.03
10	What are the advantages disadvantages and applications of FEM	Understand	CO 1	AAE009.01
	Part - C (Problem Solving and Critical Thinking Questions)			
1	Consider the following figure. An axial load P=200 KN is applied as shown a) Determine the nodal displacements. b) Determine the stress in each material. c) Determine the reaction forces.  	Understand	CO 1	AAE009.05
2	In the figure given below, a load P=60 KN is applied as shown. Determine the displacement field, stress and support reactions in the body. Take E as 20 GPa  	Understand	CO 1	AAE009.05
3	Consider the thin (steel) plate in figure. 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 expressions for the element stiffness matrices and element body force vectors b) Determine the stresses in each element and reaction force at the support. Consider 1in= 1cm for SI units  	Understand	CO 1	AAE009.05
4	Consider the bar shown in figure Determine the a) nodal displacements b) Element stresses and support reactions. E = 200 GPa  	Understand	CO 1	AAE009.05
5	A bar is subjected to an axial force is divided into a number of quadratic elements. For a particular element the nodes 1, 3, 2 are located at 15mm,	Understand	CO 1	AAE009.05

	18mmand 21mmrespectivelly from origin. If the axial displacements of the three nodes are given by u1=0.00015mm,u3=0.0033and u2=0.00024mm. Determine the following a) shape function b) variation of the displacement u(x) in the element c) axial stain in the element			
6	Consider the following fig. An axial load P=200 KN is applied as shown. Using an elimination approach, do the following a) Determine the nodal displacements. b) Determine the stress in each material. 	Understand	CO 1	AAE009.05
7	A stepped bar is subjected to an axial (vertical) force P = 108 N at node 2 as shown in figure. If the areas of the cross section of the steps are given by A1 = 0.1 m2 and A2 = 0.05 m2 and Young's moduli E1 = 200 GPa and E2 = 70 GPa, determine the following a) The displacements of node 3 b) The displacements of nodes and the stresses in two steps 	Understand	CO 1	AAE009.05
8	An axial load P=300X103N is applied at 200 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. 	Understand	CO 1	AAE009.05
9	An axial load P = 200×103 N is applied on a bar as shown in figure. Determine nodal displacements, stress in each material and reactions. 	Understand	CO 1	AAE009.05
10	Determine the nodal displacement, Element stresses for axially loaded bar as shown in the figure below 	Understand	CO 1	AAE009.05

	UNIT-II			
	ANALYSIS OF TRUSSES AND BEAMS			
	Part – A (Short Answer Questions)			
1	Represent the truss in local coordinate system and global coordinate system.	Remember	CO 2	AAE009.09
2	Write the transformation matrix of a truss.	Remember	CO 2	AAE009.07
3	Write the stress equation for truss elements	Remember	CO 2	AAE009.07
4	Write the stiffness matrix for a plane truss.	Remember	CO 2	AAE009.07
5	Write the stiffness matrix for a space truss.	Remember	CO 2	AAE009.08
6	Write the expression for element stiffness matrix of a beam	Remember	CO 2	AAE009.06
7	What is the load vector expression for a cantilever beam carrying UDL over its entire span?	Remember	CO 2	AAE009.09
8	What is the expression for UDL load vector of simply supported beam	Remember	CO 2	AAE009.05
9	What is the load vector expression for a cantilever beam carrying point load at its end?	Remember	CO 2	AAE009.09
10	Write the stiffness matrix for a beam.	Remember	CO 2	AAE009.06
	Part - B (Long Answer Questions)			
1	What is a beam? Derive the shape functions for beams and draw the shape functions.	Understand	CO 2	AAE009.08
2	Derive the stiffness matrix for beam elements.	Understand	CO 2	AAE009.06
3	Derive the stiffness matrix for two dimensional plane truss elements.	Understand	CO 2	AAE009.07
4	Assemble the global stiffness matrix and nodal displacement-for the fig. shown below Understand the problem by using SI units only. Take 1lb = 4.44N 1 in2 = 645.16 mm21psi = 6.89 KP 1in = 25.4mm 	Understand	CO 2	AAE009.09
5	Find the deflection at the load and the slopes at the ends for the steel shaft shown in figure. Consider the shaft to be simply supported at bearings A and B. Solve by FEM technique. Take E = 200 GPa. 	Understand	CO 2	AAE009.09
6	For the truss shown in figure. Determine the displacements and stresses in the bars 	Understand	CO 2	AAE009.09

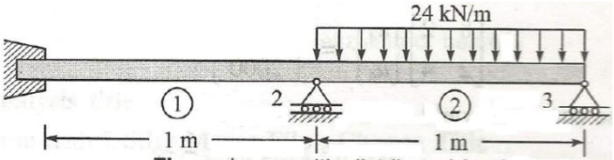
<table>
<tr><td>7</td><td>For the beam shown in Figure below, determine the following:
a) Slopes at nodes 2 and 3.
b) Vertical deflection at the mid-point of the distributed load.
Consider all the elementshave E=200GPa, I=5X106 mm4.


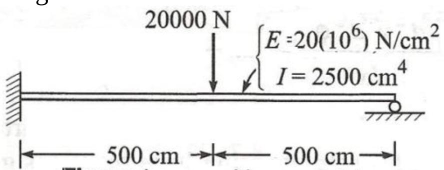
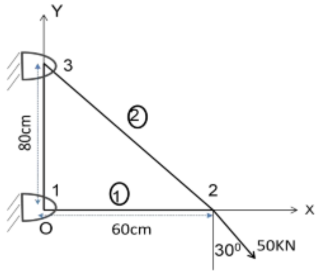
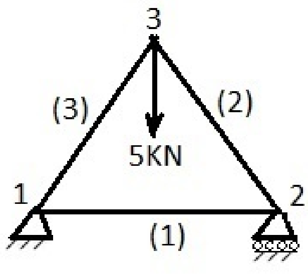
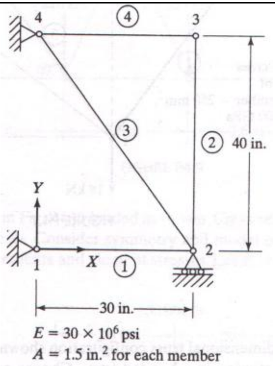
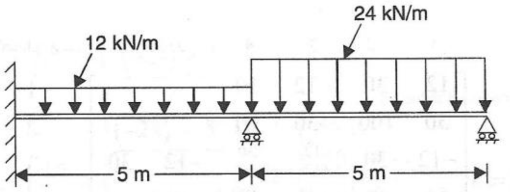
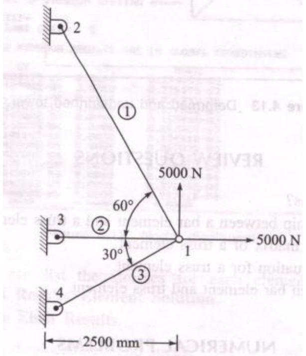
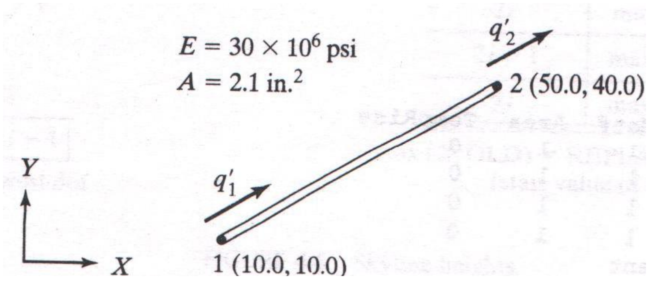
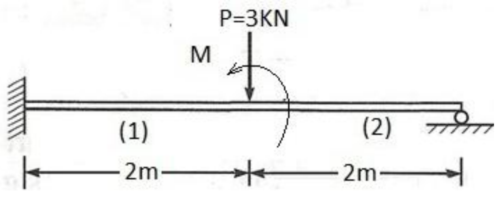
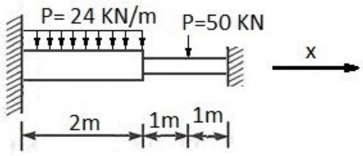
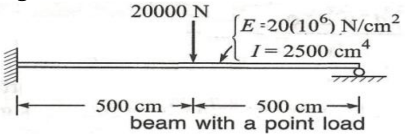
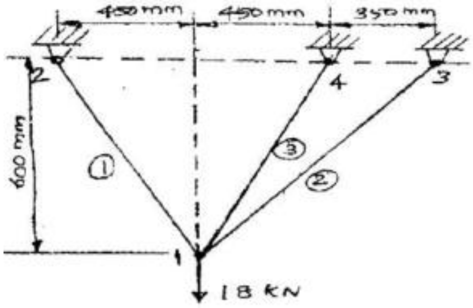
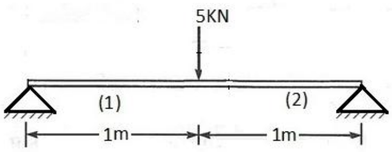
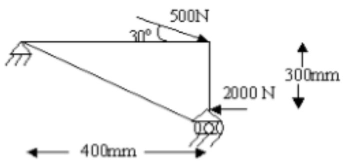
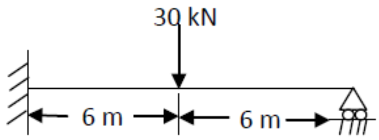
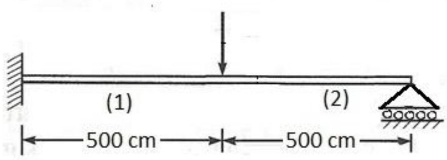
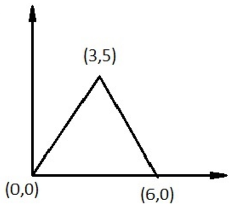
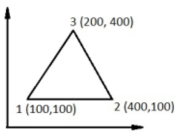
Figure beam with distributed load</td><td>Understand</td><td>CO 2</td><td>AAE009.09</td></tr>
<tr><td>8</td><td>A beam fixed at one end and supported by a roller at the other end, has a 20kN concentrated load applied at the centre of the span (Figure below). Calculate the deflection under the load and construct the shear force and bending moment diagrams for the beam.


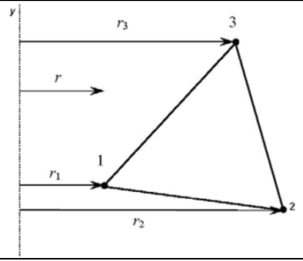
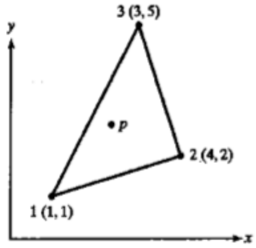
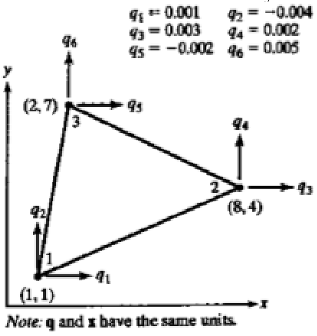
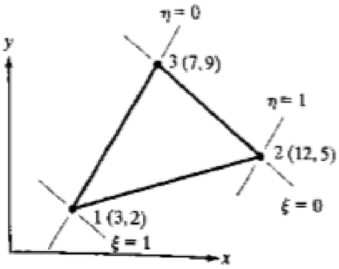
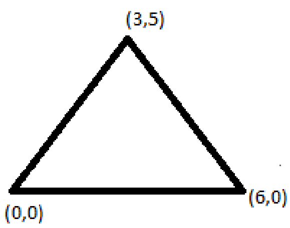
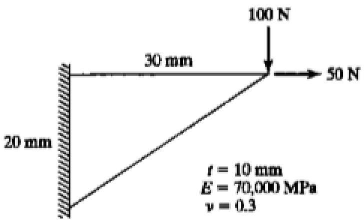
Figure beam with a point load</td><td>Understand</td><td>CO 2</td><td>AAE009.09</td></tr>
<tr><td>9</td><td>Calculate nodal displacement and element stresses for the truss shown in figure. Take E= 70 GPa and cross sectional area A=2 cm2 for all truss members.

</td><td>Understand</td><td>CO 2</td><td>AAE009.09</td></tr>
<tr><td>10</td><td>Determine Nodal displacements and Element stresses in the truss shown in figure. E=80GPa.


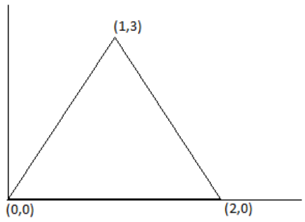
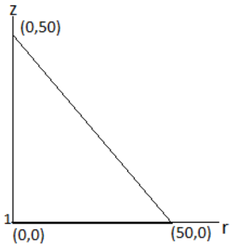
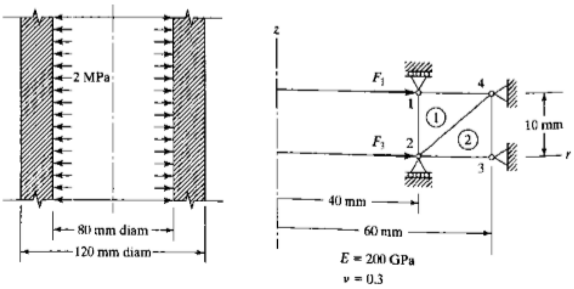
<table><tr><th>Element</th><th>Area mm^2</th><th>Length mm</th></tr><tr><td>1</td><td>600</td><td>500</td></tr><tr><td>2</td><td>600</td><td>600</td></tr><tr><td>3</td><td>600</td><td>500</td></tr></table></td><td>Understand</td><td>CO 2</td><td>AAE009.09</td></tr>
<tr><td colspan="5">Part - C (Problem Solving and Critical Thinking Questions)</td></tr>
<tr><td>1</td><td>For the truss given below, a horizontal load of P = 4000 lb is applied in the x-direction at node 2.
a) Write down the element stiffness matrix k for each element.
b) Assemble the K matrix
c) Using elimination approach, Understand for Q</td><td>Understand</td><td>CO 2</td><td>AAE009.09</td></tr>
</table>

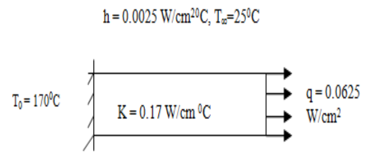
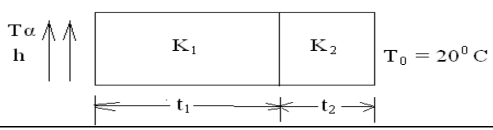
				
2	Apply the beam shown in Figure below by finite element method and determine the end reactions. Also determine the deflections at mid spans given E=2X105N/mm2, and I=5X106 mm^4. 	Understand	CO 2	AAE009.09
3	For the truss shown in fig, Understand for the horizontal and vertical components of displacement at node 1 and determine the stress in each element. All elements have A = 500 mm2 and E = 70 GPa. 	Understand	CO 2	AAE009.09
4	For the truss element shown below, determine the following: a) The K matrix b) The nodal vector q c) The stress in the element 	Understand	CO 2	AAE009.09
5	Determine the nodal displacements and slopes for the beam shown in fig. find the moment at the midpoint of element. Take E=200 GPa,,I=5 x 104 mm4, M=6KN-M. 	Understand	CO 2	AAE009.09
6	Determine the deflection and slope under the point load for the beam shown in fig given. E=200 GPa, I= 4 x 10-6m4, I2=2 x 10-6m4.	Understand	CO 2	AAE009.09

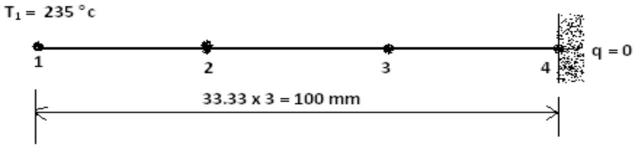
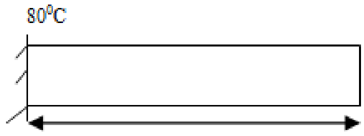
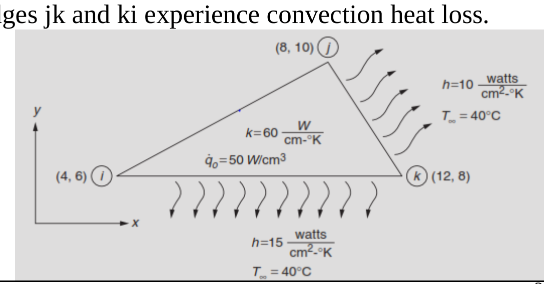
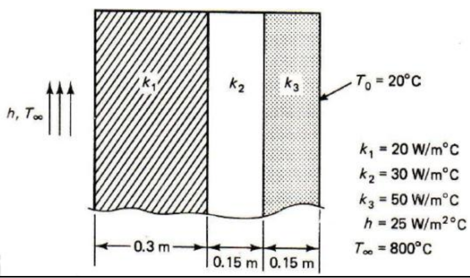
				
7	A beam fixed at one end and supported by a roller at the other end, has a 20kN concentrated load applied at the centre of the span (Figure below). Calculate the deflection under the load and construct the shear force and bending moment diagrams for the beam.  beam with a point load	Understand	CO 2	AAE009.09
8	For a three bar truss shown in figure, determine the displacements in node 1 and the stress in element 3. Take E = 250 mm2, E = 200 GPa. 	Understand	CO 2	AAE009.09
9	Determine the nodal displacements and slopes at the position of one-fourth distance from the support of shaft: Take E=200 GPa,,I=6 x 104mm4. The shaft is simply supported at A and B. 	Understand	CO 2	AAE009.09
10	Estimate the displacement vector, stresses for the truss structure as shown below figure. Take E=2×105N/mm2. 	Understand	CO 2	AAE009.09
11	Calculate the deflection under load, shear force and bending moment at mid span and reactions at supports for the beam shown in figure. Take E=200 GPa and I= 24×10-6 m^4. 	Understand	CO 2	AAE009.09
12	A beam fixed at one end and supported by a roller at the end, has a 20KN concentrated load applied at the centre of the span, as shown in fig. calculate the deflection under the load and construct shear force and bending moment diagram for the beam. Take E = 20 x 106 N/c,2, I=2500 cm^4.	Understand	CO 2	AAE009.09

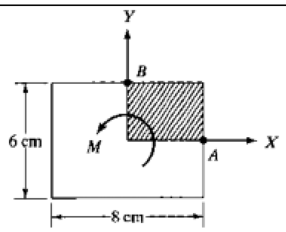
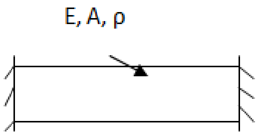
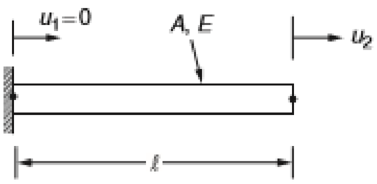
				
UNIT -III				
CONTINUUM ELEMENTS				
Part - A (Short Answer Questions)				
1	What is a CST element with example?	Remember	CO 3	AAE009.12
2	List any four two dimensional elements	Remember	CO 3	AAE009.11
3	Represent the node numbering of Constant strain triangle element.	Remember	CO 3	AAE009.12
4	What is LST element with example?	Remember	CO 3	AAE009.12
5	What is the condition for number of unknown polynomial coefficients of a 2-D element	Remember	CO 3	AAE009.13
6	Define plane stress and plane strain	Remember	CO 3	AAE009.10
7	Write the expression of traction force for four node quadrilateral element.	Remember	CO 3	AAE009.12
8	Represent the node numbering of Linear strain triangle element.	Remember	CO 3	AAE009.13
9	What is meant by axi symmetric solid?	Remember	CO 3	AAE009.10
10	Differentiate between linear and nonlinear elements.	Remember	CO 3	AAE009.11
11	What is isoparametric representation	Remember	CO 3	AAE009.11
12	What are the conditions for a problem to be axisymmetric?	Remember	CO 3	AAE009.10
Part – B (Long Answer Questions)				
1	Derive the strain displacement matrix for triangular element	Understand	CO 3	AAE009.10
2	Derive the Jacobian of transformation	Understand	CO 3	AAE009.11
3	Derive force terms for constant strain triangle.	Understand	CO 3	AAE009.10
4	Differentiate CST and LST elements.	Understand	CO 3	AAE009.12
5	Define Iso-parametric, Super Parametric and Sub-Parametric elements	Understand	CO 3	AAE009.10
6	Apply the element stiffness matrix for the triangular element shown in figure under plane strain condition. Assume the following values. E=200 GPa, μ=0.25, t=1 mm. 	Understand	CO 3	AAE009.12
7	Determine the nodal displacements and element stresses for the two dimensional loaded plate as shown in figure. Assume planestress conditions. Body force may be neglected in comparison to the external forces. Take E=210 GPa, μ=0.25; thickness = 10mm. 	Understand	CO 3	AAE009.12
8	Derive the shape function for four noded Quadrilateral Element.	Understand	CO 3	AAE009.12
9	Derive the shape function and strain displacement matrices for triangular element of revolving body	Understand	CO 3	AAE009.10
10	Derive the element stiffness matrix for four noded quadrilateral element	Understand	CO 3	AAE009.10
11	Derive the stiffness matrix for axisymmetric element.	Understand	CO 3	AAE009.11
12	Evaluate the axisymmetric stiffness matrix K of the triangular element shown in the figure. Consider the coordinates of nodes as 1 (2, 1), 2 (4, 0), and 3 (3, 2). Also assume E = 2.6 GPa andν = 0.2.	Understand	CO 3	AAE009.11

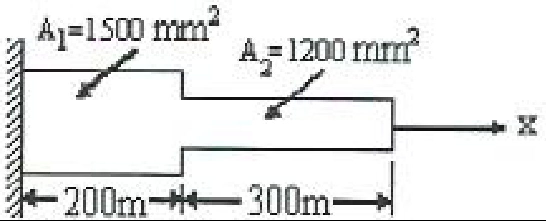
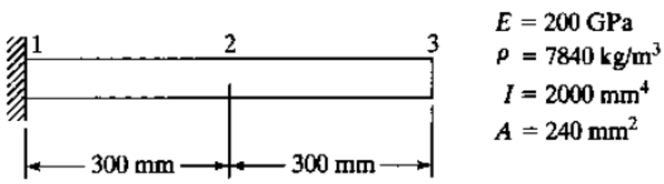
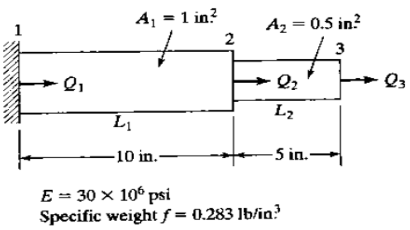
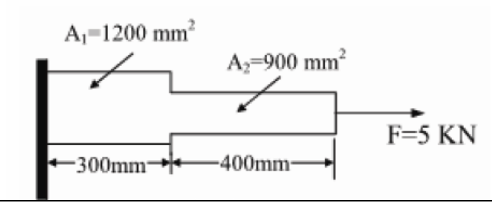
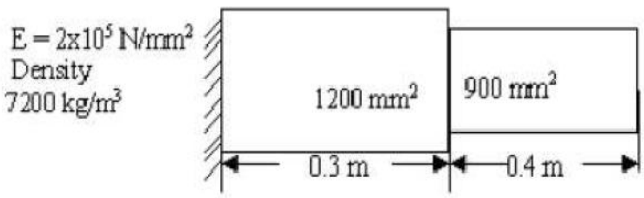
				
13	Define Iso-parametric, Super Parametric and Sub-Parametric elements?	Understand	CO 3	AAE009.10
	Part – C (Problem Solving and Critical Thinking)			
1	For the point P located inside the triangle, the shape functions N1 and N2 are 0.15 and 0.25, respectively. Determine the x and y coordinate of P. 	Understand	CO 3	AAE009.10
2	For the triangular element shown in figure, obtain strain-displacement relation matrix B and determine the strains ε_x, ε_y and γ_{xy}. 	Understand	CO 3	AAE009.10
3	Determine the jacobian for the (x, y) – (ξ, η) transformation for the element shown in fig, also find the area of the triangle. 	Understand	CO 3	AAE009.11
4	For the plane stress element shown in figure, determine the stiffness matrix. Assume E=200 GPa and μ=0.3.Thickness =10 mm 	Understand	CO 3	AAE009.10
5	For the two dimensional plate shown in figure, determine the deflection at the point of load application. 	Understand	CO 3	AAE009.11

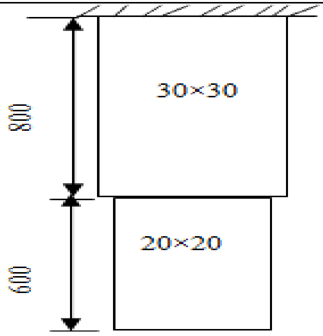
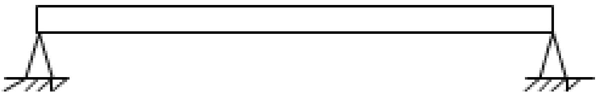
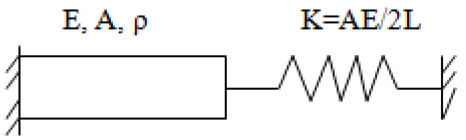
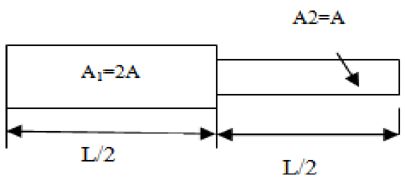
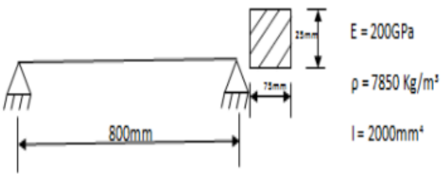
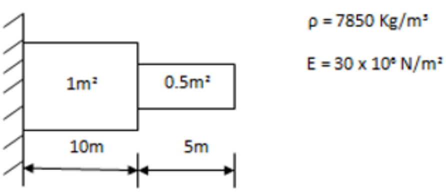
6	Calculate the element stiffness matrix and thermal force vector for the plane stress element shown in figure. The element experiences a rise of 10^0C.E=15×104 N/mm^2, t=5 mm, μ=0.25, α=6×10-6 /^{0}C 	Understand	CO 3	AAE009.11
7	For the axisymmetric element shown in figure. Determine the stiffness matrix. Let E=2.1×10^5 MN/m^2 and μ=0.25. The coordinates are in mm. 	Understand	CO 3	AAE009.10
8	The (x,y) co-ordinates of nodes i, j and k of an axisymmetric triangular element are given by (3.4), (6,5) and (5,8) cm respectively. The element displacement (in cm) vector is given as q= [0.002, 0.001, 0.004, -0.003, 0.007]^T. Determine the element strains.	Understand	CO 3	AAE009.11
9	A long cylinder of inside diameter 80 mm and outside diameter 120 mm snugly fits in a hole over its full length. The cylinder is then subjected to an internal pressure of 2 MPa. Using two elements on the 10 mm length shown, find the displacements at the inner radius. 	Understand	CO 3	AAE009.11
10	A four noded rectangular element is shown in figure. Determine Jacobian matrix, Strain displacement matrix and element stresses. Take E=2×10^5 N/mm^2, μ=0.5, u=[0, 0, 0.005, 0.008, 0.008, 0,0]^T, ε= 0,η=0 	Understand	CO 3	AAE009.12
11	The Cartesian global coordinates of the corner nodes of an isoparametric quadrilateral element are given by (1,0), (2,0), (2.5, 1.5) and (1.5,1). Find its Jacobian matrix.	Understand	CO 3	AAE009.12
	UNIT -IV			
	STEADY STATE HEAT TRANSFER ANALYSIS			
	Part – A (Short Answer Questions)			
1	Define steady state heat transfer.	Remember	CO 4	AAE009.13
2	Define fins or extended surfaces	Remember	CO 4	AAE009.14
3	Write the basic equation of heat transfer.	Remember	CO 4	AAE009.13
4	Specify the applications of heat transfer problems.	Remember	CO 4	AAE009.13

5	What is conduction and convetion heat transfer?	Understand	CO 4	AAE009.13
6	Write thermal conductivity matrix for two dimensional heat transfer problems.	Remember	CO 4	AAE009.14
7	Differentiate between convection and radiation heat transfer.	Understand	CO 4	AAE009.13
8	Formulate the equation of one dimensional criteria of composite wall.	Understand	CO 4	AAE009.15
9	Define the terms thermal conductivity and convection heat transfer coefficient.	Understand	CO 4	AAE009.13
10	Analyse the heat transfer characteristics of fins.	Understand	CO 4	AAE009.13
11	Write the finite element equation for 1dimensional heat conduction element.	Remember	CO 4	AAE009.14
	Part – B (Long Answer Questions)			
1	Derive thermal stiffness matrix for one dimensional heat conduction with lateral surface convection and with internal heat generation.	Understand	CO 4	AAE009.13
2	Describe heat transfer analysis for composite wall.	Understand	CO 4	AAE009.15
3	What are different types of boundary conditions for 1D heat conduction problems?	Understand	CO 4	AAE009.13
4	Consider a brick wall of thickness L=30 cm, k=0.7 W/m^{0}C. The inner surface is at 28^{0}C and the outer surface is exposed to cold air at -15^{0}C. The heat transfer coefficient associated with the outside surface is h=40 W/m^{20}C. Determine the steady state temperature distribution within the wall and also the heat flux through the wall.	Understand	CO 4	AAE009.15
5	Derive the finite element equation for straight fin.	Understand	CO 4	AAE009.14
6	Derive the conductivity matrix for two dimensional triangular element subjected to convection on one face of the element.	Understand	CO 4	AAE009.13
7	Calculate the temperature distribution in the stainless steel fin of circular cross section length 10 cm shown in figure. The cross section of the fin is circular with diameter of 2 cm. Discretize the fin into 5 elements. 	Understand	CO 4	AAE009.14
8	A furnace wall is made up of three layers, inside layer with thermal conductivity 8.5 W/mK, the middle layer with conductivity 0.25 W/mK the outer layer with conductivity 0.08 W/mK. The respective thicknesses of the inner, middle and outer layer are 25 cm, 5 cm and 3 cm respectively. The inside temperature of the wall is 600^{0}C and the outside of the wall is exposed to atmospheric air at 30^{0}C with heat transfer coefficient of 45 W/m^{2}K. Determine the nodal temperatures.	Understand	CO 4	AAE009.15
9	Explain the methodology for the treatment of all three boundary conditions in a 1-D heat transfer element?	Understand	CO 4	AAE009.13
10	Derive one dimensional steady state heat conduction equation and apply to one dimensional fin problem	Understand	CO 4	AAE009.14
11	Derive stiffness matrix for 1-D heat conduction problem.	Understand	CO 4	AAE009.13
12	Derive the conductivity matrix and thermal load vector for the one dimensional finite element for the three boundary conditions.	Understand	CO 4	AAE009.13
13	Derive angle of twist for a uniform shaft subjected to torsion.	Understand	CO 4	AAE009.13
	Part – C (Problem Solving and Critical Thinking)			
1	Determine the temperature distribution through the composite wall shown in figure, when convection heat loss occurs on the left surface. Assume unit area. Assume wall thickness t_1 = 4cm, t_2 = 2cm, k_1 = 0.5w/cm^{0}c, k_2 = 0.05w/cm^{0}c, h= 0.1w/cm$^{2\ 0}$c and T_α= -5^{0}c. 	Understand	CO 4	AAE009.15
2	Determine the nodal temperature in a composite wall, the wall is maintained at 100 deg c at the left face and convection mode of heat transfer occurs between the right face and existing fluid .take k_1=0.06w/cm	Understand	CO 4	AAE009.15

	deg c and k_2=0.2w/cm deg c, convection co efficient of heat transfer between walls and fluid h=0.1w/cm^{20}C and T_∞=25^{0}C. Consider unit area=1 cm^2 perpendicular to the direction of heat flow.			
3	A metallic fin with thermal conductivity K=360W/m^{0}c, 1mm thick and100mm long extends from a plane wall whose temperature is 235^{0}c. Determine the distribution and amount of heat transferred from the fin to air at 20^{0}c with h= 9W/m^{20}c take width of the fin is 1000 mm. Assume tip is insulted.  	Understand	CO 4	AAE009.14
4	Calculate the temperature distribution in a one dimensional fin with the physical properties k = 3 W/ cm ^{0}C, h = 0.1 W/cm^{20}C, T_∞= 20^{0}C. the fin is rectangular in shape and is 8 cm long, 4 cm wide and 1 cm thick. Assume that convection heat loss occurs from the end of the fin.  	Understand	CO 4	AAE009.14
5	A metallic fin 0.15 cm thick and 12 cm long is attached to a furnace whose wall temperature is 2200C. If the thermal conductivity of the material of the fin is 350 W/m^{0}C and convection coefficient is 9 W/m^{20}C, determine the temperature distribution if the width of the fin is 2 cm. Assume that the tip of the fin is open to the atmosphere and that the ambient temperature is 25^{0}C.	Understand	CO 4	AAE009.14
6	Compute the element matrices and vectors for the element shown in figure when the edges jk and ki experience convection heat loss.  	Understand	CO 4	AAE009.13
7	Heat is entering into a large plate at the rate of q_0 = -300 W/m^2. The plate is 25 mm thick. The outside surface of the plate is maintained at a temperature of 10^{0}C. Using two finite elements solve for the vector of nodal temperatures T. Thermal conductivity k = 1.0 W/m^{0}C.	Understand	CO 4	AAE009.13
8	A composite wall consists of three materials as shown in figure. The outer temperature isT_0 = 200C. Convection heat transfer takes place on the inner surface of the wall with T_∞=8000C and h= 25 W/m^{2o}C. Determine the temperature distribution in the wall.  	Understand	CO 4	AAE009.15
9	A bar of length 10 cm with rectangular section of width 3 cm and depth 2 cm is experiencing a temperature of 90^0 C at its left end. Assuming convection over the length of bar obtain the temperature distribution along the length. Use two 1D elements with nodes at its ends and the following data k = 5 W/ cm ^{0}C, h = 0.2 W/ cm^{20}C, T_∞ = 25^{0}C	Understand	CO 4	AAE009.13
10	Consider the shaft with rectangular cross section shown in figure. Determine in terms of M and G, the angle of twist per unit length.	Understand	CO 4	AAE009.13

				
UNIT -V				
DYNAMIC ANALYSIS				
Part - A (Short Answer Questions)				
1	What is lumped mass matrix?	Remember	CO 5	AAE009.16
2	What is consistent mass matrix?	Remember	CO 5	AAE009.16
3	Write the expression for element mass matrix for a bar element?	Remember	CO 5	AAE009.17
4	Define the terms vibration and natural frequency.	Remember	CO 5	AAE009.16
5	Write the expression for element mass matrix for a truss element?	Remember	CO 5	AAE009.18
6	What are the convergence requirements in finite element modeling?	Remember	CO 5	AAE009.18
7	Write the expression for modal analysis of bar and beam elements.	Remember	CO 5	AAE009.18
8	Give some practical problems associated with finite element modeling.	Remember	CO 5	AAE009.16
9	Write the expression for element mass matrix for a CST element?	Remember	CO 5	AAE009.18
10	List out factors influencing the accuracy of the results	Understand	CO 5	AAE009.16
11	Define dynamic analysis.	Remember	CO 5	AAE009.17
Part - B (Long Answer Questions)				
1	Derive element mass matrix for one dimensional bar element	Understand	CO 5	AAE009.18
2	Find the natural frequencies and mode shapes of a uniform cantilever beam using one beam element and consistent mass matrix.	Understand	CO 5	AAE009.18
3	Distinguish between consistent mass matrix and lumped mass matrices	Understand	CO 5	AAE009.18
4	Derive the elemental mass matrix for 1-D bar element and plane truss element.	Understand	CO 5	AAE009.18
5	State the properties of Eigen Values. Determine the eigen values and the associated Eigen vectors of the matrix [A] given by $A = \begin{bmatrix} 3 & 4 \\ 4 & -3 \end{bmatrix}$	Understand	CO 5	AAE009.18
6	Explain Lumped parameter model and Continuous system model with examples.	Understand	CO 5	AAE009.17
7	Determine the mass matrix for truss element with an example.	Understand	CO 5	AAE009.18
8	Obtain the natural frequency of flexural vibration of a fixed beam of uniform cross-section. Use two element idealizations. 	Understand	CO 5	AAE009.16
9	Derive the consistent mass matrix for a truss element in its local coordinate system.	Understand	CO 5	AAE009.18
10	Determine the first natural frequency of longitudinal vibration of a bar fixed at one end using two linear elements.	Understand	CO 5	AAE009.18
11	Discuss the importance of semi-automatic meshing and auto mesh along with the practical applications	Understand	CO 5	AAE009.16
12	Find the natural frequency of vibration of a fixed-free bar in axial motion based on a one-element model using (a) consistent mass matrix and (b) lumped mass matrix. 	Understand	CO 5	AAE009.18

Part – C (Problem Solving and Critical Thinking)				
1	Consider axial vibration of the steel bar shown in figure below. Develop the global stiffness mass matrix and determine the natural frequencies and mode shapes using the characteristic polynomial technique. 	Understand	CO 5	AAE009.18
2	Evaluate the lowest Eigenvalue and the corresponding Eigenmode for the beam shown in Figure below 	Understand	CO 5	AAE009.18
3	Determine the Eigen values and Eigen vectors for the stepped bar shown in Figure below. 	Understand	CO 5	AAE009.18
4	Consider axial vibration of the Aluminium bar shown in Figure below, develop the global stiffness and determine the nodal displacements and stresses using elimination approach and with help of linear and quadratic shape function concept. Assume Young's Modulus E = 70Gpa. 	Understand	CO 5	AAE009.18
5	Find the natural frequencies in the vibration of two element simply supported beam having the parameters as length L= 2m, area of cross section A = 30 cm^2, moment of inertia I=400 mm^{4}density ρ = 7800 kg/m^3 and Young's modulus E = 200 GPa.	Understand	CO 5	AAE009.18
6	Consider the axial vibrations of a steel bar shown in the figure a) Develop global stiffness and mass matrices b) Determine the natural frequencies? 	Understand	CO 5	AAE009.18
7	Determine the first two natural frequencies of longitudinal vibration of the stepped bar shown in figure and plot the mode shapes. All the dimensions are in mm E = 200 GPa and ρ = 0.78 kg/cc. what will be the effect on natural frequencies if a concentrated mass of 100 kg is added to the tip of bar?	Understand	CO 5	AAE009.18

				
8	Consider a simply supported beam which is discretized into 2 elements as shown in figure. Obtain the natural frequencies. The following data for beam is length=2m, area of cross section A=30 cm^2, moment of inertia I = $400mm^4$, mass density ρ = 7800 kg/m^3. 	Understand	CO 5	AAE009.18
9	Determine the natural frequencies of the system in figure. Consider at least two elements. 	Understand	CO 5	AAE009.18
10	Find the natural frequencies of longitudinal vibration of the unconstrained stepped bar shown in figure 	Understand	CO 5	AAE009.18
11	Determine all natural frequencies of the simply supported beam as shown in figure? 	Understand	CO 5	AAE009.18
12	Determine the Eigen values and Eigen Vectors for the stepped bar as shown in figure? 	Understand	CO 5	AAE009.18

Prepared by:
Ms. Ch RaghaLeena, AssistantProfessor

HOD, AE