INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

TUTORIAL QUESTION BANK

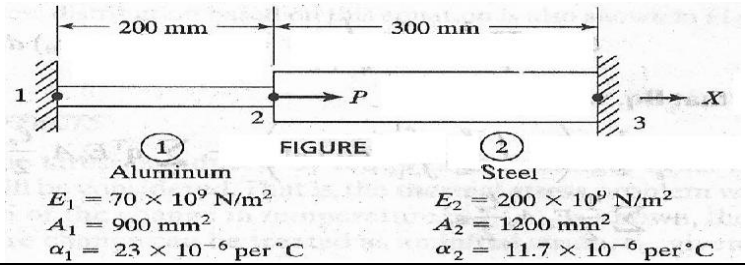
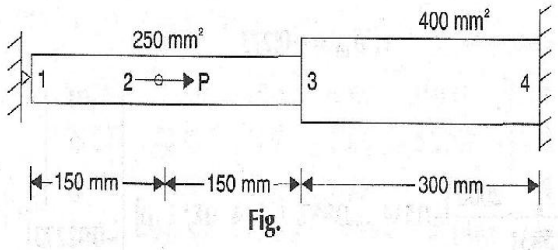
Course Name	:	**FINITE ELEMENT METHODS**
Course Code	:	**A60330**
Class	:	**III - II**
Branch	:	**MECHANICAL ENGINEERING**
Year	:	**2017– 2018**
Team of Instructors	:	**Prof VVSH Prasad, C. Labesh Kumar Asst. Professor**

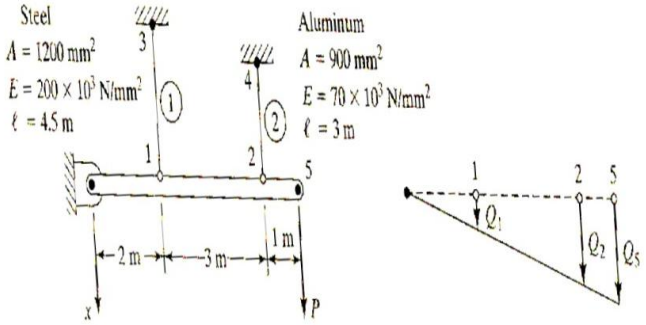
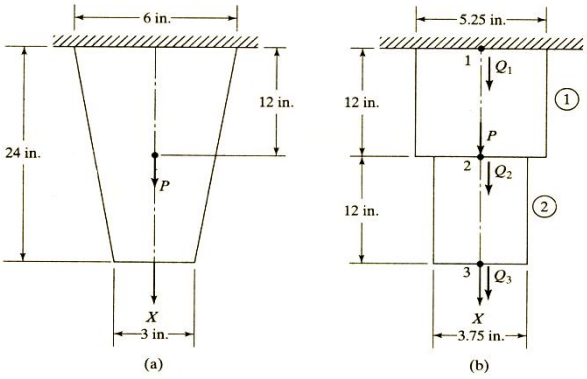
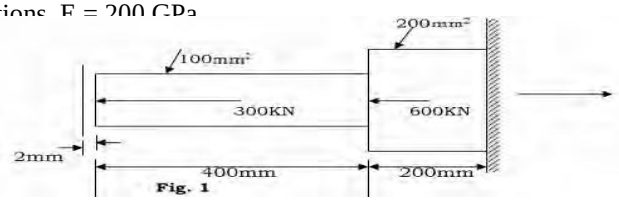
OBJECTIVES:

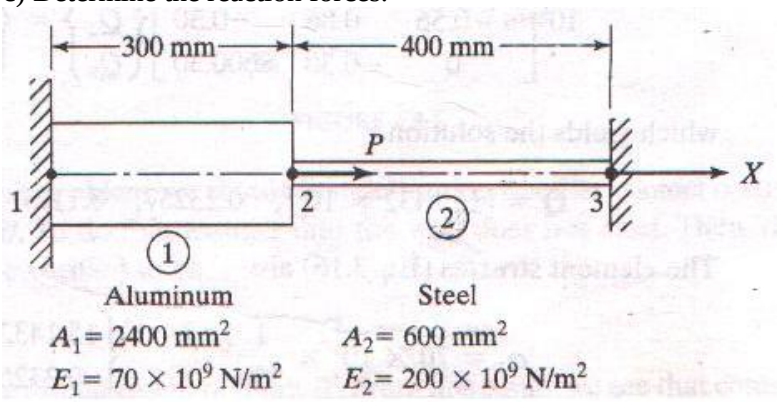
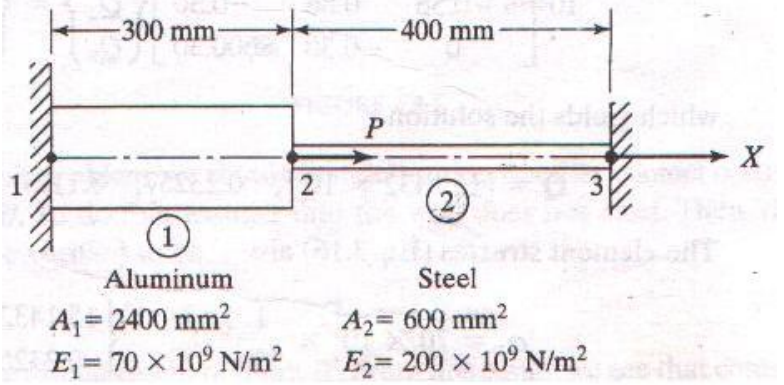
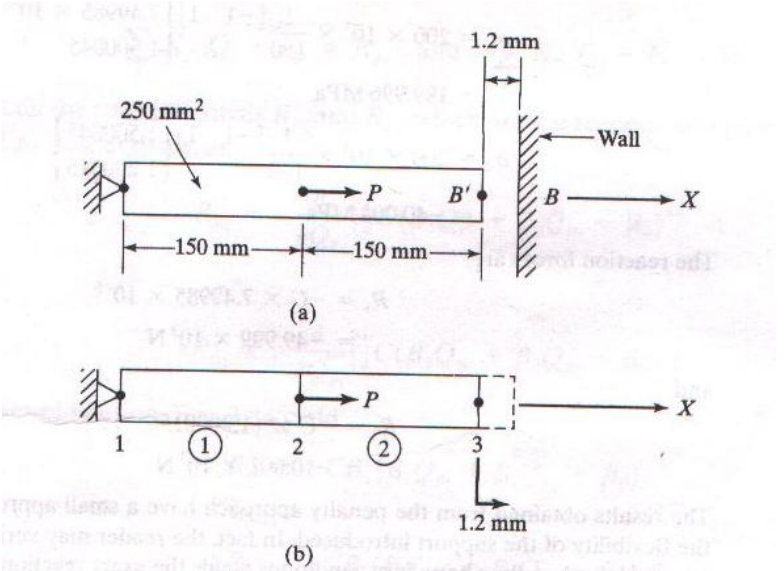
To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited.

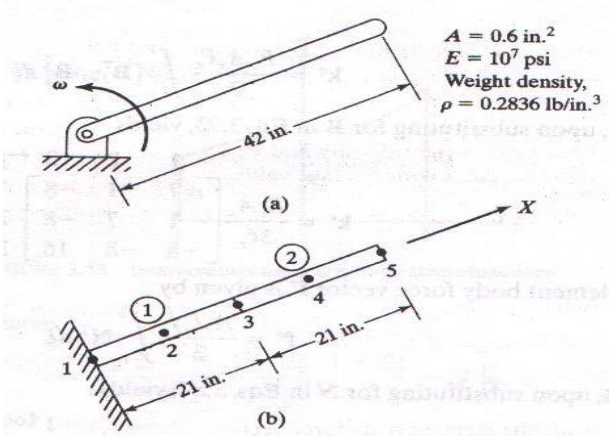
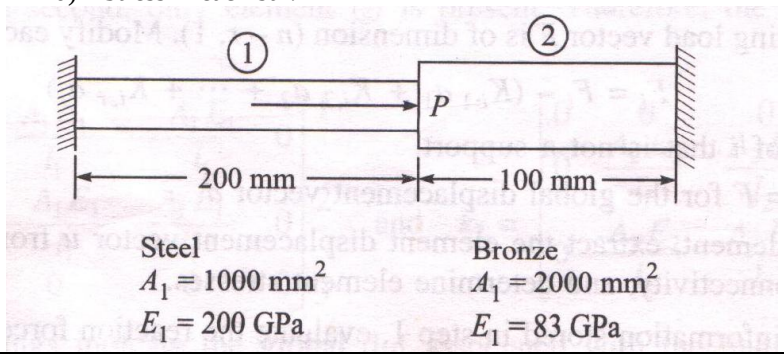
In line with this, Faculty of Institute of Aeronautical Engineering, Hyderabad has taken a lead in incorporating philosophy of outcome based education in the process of problem solving and career development. So, all students of the institute should understand the depth and approach of course to be taught through this question bank, which will enhance learner's learning process.

S. No.	Question	Blooms Taxonomy Level	Course Outcomes
	UNIT-I		
Short Answer Questions			
1	Explain finite element method?	Understand	1
2	Define degree of freedom.	Understand	1
3	Define boundary condition.	Understand	1
4	What is local and global stiffness matrix.	Understand	1
5	What is the unit of stiffness?	Understand	1
6	What is global force vector?	Understand	1
7	What do you mean by body force?	Understand	1
8	What do you mean by traction force?	Understand	1
9	What are the units of body force?	Understand	1
10	What are the units of traction force?	Understand	1
11	What are the examples of body force?	Understand	1
12	What are the examples of traction force?	Understand	1
14	What is the governing equation of F.E.M?	Understand	1
15	Define potential energy.	Understand	1
16	Define strain energy.	Remember	1
17	Give the expression for total potential energy.	Understand	1
18	Give the expression for shape functions of a linear element.	Understand	1
19	Draw the shape functions of a linear element.	Understand	1

20	Write the expression for the shape functions of a quadratic element.	Understand	1
21	Draw the shape functions of a quadratic element.	Understand	1
22	What is the element stiffness matrix for a linear element?	Remember	1
23	What is the element stiffness matrix for a quadratic element?	Remember	1
24	What is specified boundary condition?	Understand	1
25	What is multipoint constraint?	Remember	1
26	What is the expression for initial strain?	Remember	1
27	How stress will change with the effect of temperature?	Remember	1
28	What is the expression for a reaction force of linear element?	Remember	1
Long Answer Questions			
1	Using variational approach (potential energy), describe FE formulation for 1D bar element.	Understand	1,3
2	Using potential energy approach, describe FE formulation for plane truss Element.	Understand	1,2
3	Define principle of virtual work. Describe the FEM formulation for 1D bar element.	Remember	1,3
4	Explain the concept of FEM briefly and outline the steps involved in FEM along with remembers.	Understand	1,4
5	Describe the elimination approach, with an example.	Remember	1
6	Describe the penalty approach for multipoint constraint with an example.	Remember	2,4
7	Discuss in detail about the concepts of FEM formulation .How is that FEM emerged as a powerful tool.	Understand	3,1
8	Discuss in detail about remembers of finite element method	Understand	1
9	Derive element stiffness matrix and load vector for quadratic element using potential energy approach.	Understand	2,3
10	Explain the concept of FEM briefly .outline the steps involved in FEM along with remembers.	Understand	1
11	Draw the shape functions of a quadratic element.	Understand	1,2
12	Explain the elimination method and penalty method for imposing specified displacement boundary conditions	Understand	1,3
13	An axial load P=300X10^{3}N is applied at 20^0 C to the rod as shown in Figure below. The temperature is the raised to 60^0 C . a) Assemble the K and F matrices. b) Determine the nodal displacements and stresses.  	Remember	1,4
14	Determine the nodal displacement, Element stresses for axially loaded bar as shown in the fig. below  Fig.	Remember	1
15	Derive element stiffness matrix and load vector for linear element using potential energy approach.	Understand	2,4

16	Consider the structure shown in Fig. A rigid bar of negligible mass, pinned at one end, is supported by a steel rod and an aluminum rod. A load P = 30 kN. N is applied as  shown Assemble stiffness matrix and Determine nodal displacement for above bar element	Remember	1,2
17	Consider the thin (steel) plate in Fig. The plate has a uniform thickness t =10 mm, Young's modulus E = 100Gpa, and weight density=78500N/m3 . 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) Evaluate the stresses in each element Determine the reaction force at the support. consider 1in=1cm for SI UNITS  	Understand	1,3
18	Consider the bar shown in figure loaded as shown in Determine the a)nodal displacements, b)element stresses and support reactions. E = 200 GPa  Fig. 1	Remember	1,4
19	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, 18mmand 21mmrespectivelly from origin. If the axial displacements of the three nodes are given by u_1=0.00015mm,u_3=0.0033and u_2=0.00024mm. Determine the following i)shape function ii)variation of the displacement u(x) in the element iii)axial stain in the element Derive the thermally induced stress in the two noded Bar element.	Understand	1
20	Derive element stiffness and load vector Using, Galerkin Approach.	Remember	1,4
Analytical Questions			
1	Consider the following fig. An axial load P=200 KN is applied as shown. Using penalty approach for handling boundary condtions, do the following	Understand	1,2

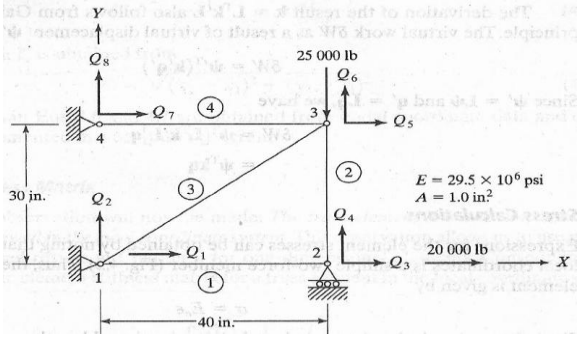
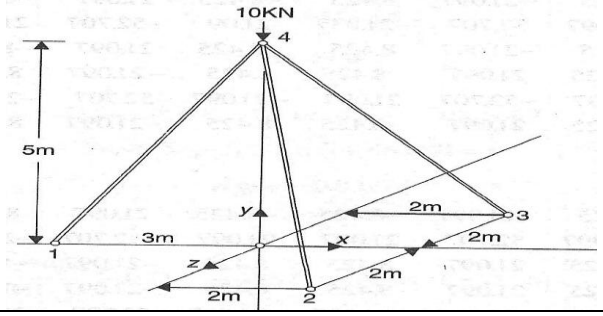
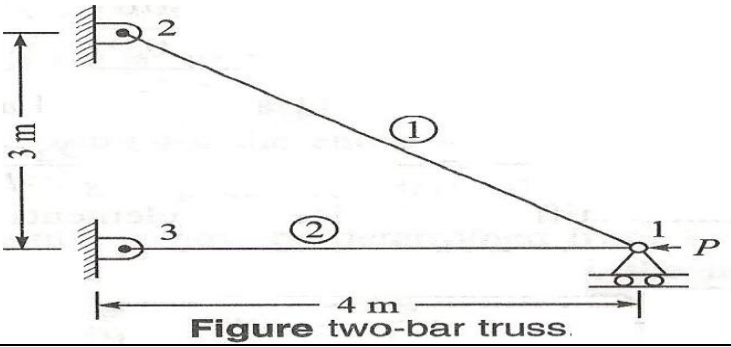
	a) Determine the nodal displacements. b) Determine the stress in each material. c) Determine the reaction forces.  		
2	Consider the following fig. An axial load P=200 KN is applied as shown. Using an elimination approach, do the following a) Determine the nodal displacements. b) Determine the stress in each material.  	Understand	1,2
3	In the fig. 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	1,2
4	Consider the rod (a robot arm), which is rotating at constant angular velocity of 30 rad/s. Determine the axial stress distribution in the rod, using two quadratic elements. Consider only the centrifugal force. Ignore bending of the rod.	Understand	1,2

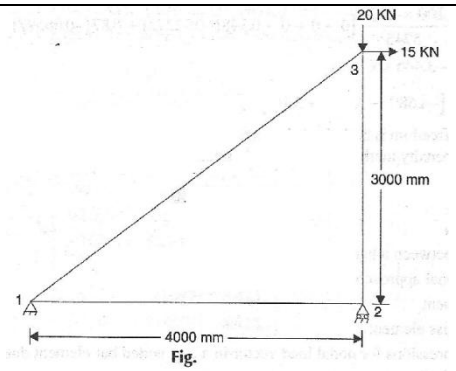
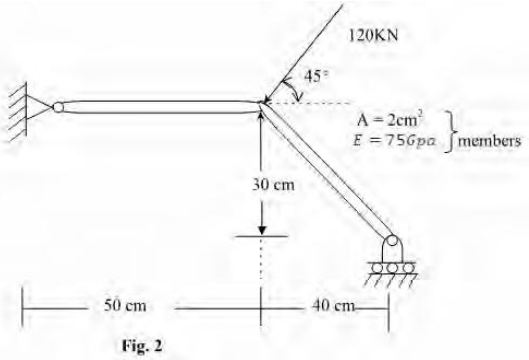
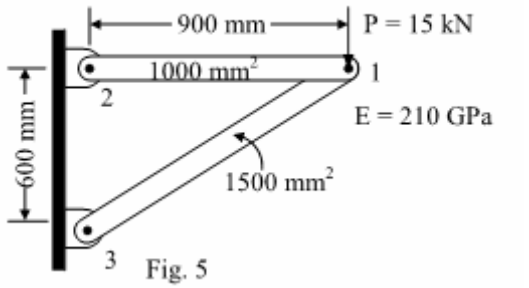
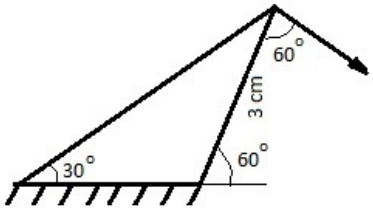
			
5	The structure consists of two bars. An axial load P=200 KN is loaded as shown in fig., determine the following: a) Element stiffness matrices b) Global stiffness matrix c) Nodal displacements. d) Stress in each bar. 	Understand	1

UNIT – II

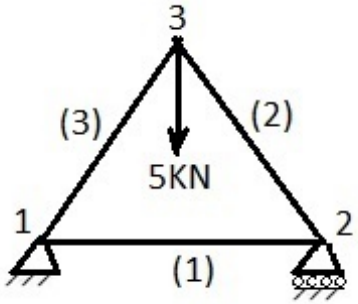
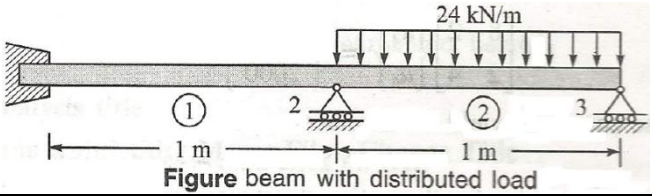
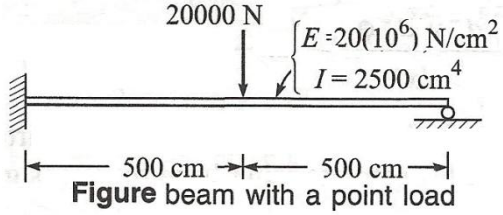
Short Answer Questions

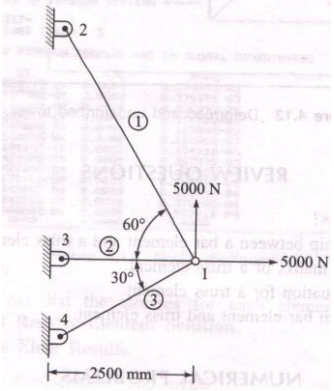
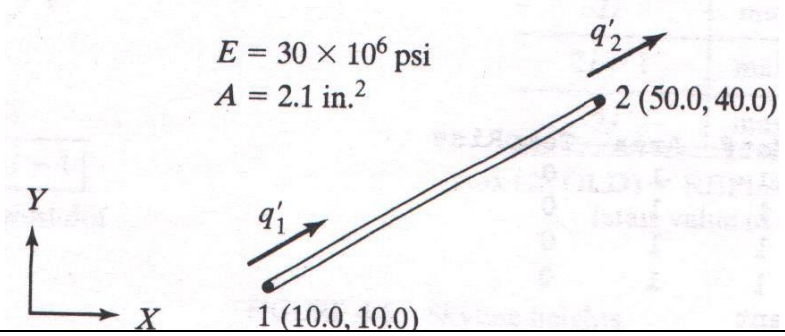
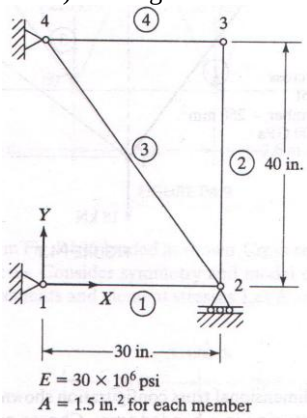
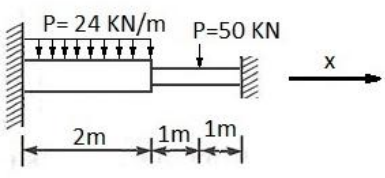
S. No.	Question	Blooms Taxonomy Level	Course Outcomes
1	Represent the truss in local coordinate system.	Understand	1
2	Represent the truss in global coordinate system.	Understand	1
3	What are the characteristics of a truss?	Understand	1
4	Draw a plane truss structure.	Understand	1
5	What is a member and joint?	Understand	1, 3
6	Give the transformation matrix of a truss.	Understand	1
7	What is the expression for element length of a truss?	Understand	1, 3
8	What is the expression for an element stiffness matrix of a truss in local coordinate system?	Understand	1, 3
9	What is the expression for strain energy in a truss element?	Understand	1
10	What is the expression for an element stiffness matrix of a truss in global coordinate system?	Understand	1, 3
11	Give the expression for the stress in a truss element in a local coordinates.	Remember	1
12	Define a beam with examples.	Understand	1, 3
13	Give the various remembers of a beam.	Understand	1
14	Draw the stress distribution diagram for a beam section.	Remember	1, 3

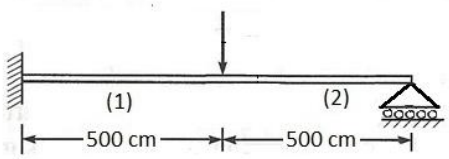
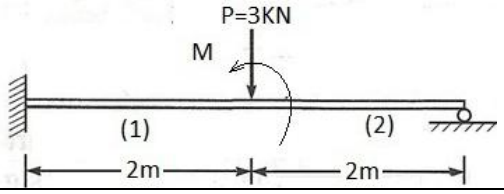
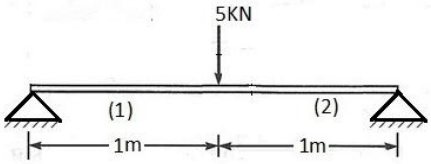
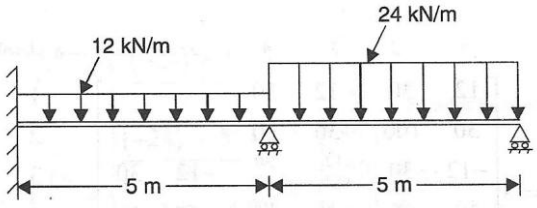
15	Give the expression for the potential energy of a beam.	Understand	1, 3
16	Draw the hermite shape functions.	Understand	1
17	Write the expression for a element stiffness matrix of a beam.	Understand	1, 3
18	What is the expression for a load vector of a beam?	Understand	1
19	What is the expression for a shear force of a beam?	Understand	1, 3
20	What is the expression for a bending moment of a beam?	Understand	3
Long Answer Questions			
1	Assemble the global stiffness matrix and nodal displacement-for the fig. shown below solve the problem by using SI units only. Take 1lb = 4.44N 1 in^2 = 645.16 $mm^2$1psi = 6.89 KP 1in = 25.4mm 	Understand	1,2
2	The tripod shown in figure below carries a vertically downward load of 10kN at joint 4. If Young's modulus of the material of tripod stand is 200kN/mm^2, determine the forces developed in the legs of the tripod. 	Remember	1,3
3	For the two-bar truss shown in Figure below, determine the nodal displacements, element stresses and support reactions. A force of P=1000kN is applied at node-1. Assume E=210GPa and A=600mm^2 for each element.  Figure two-bar truss.	Remember	1,4
4	Obtain the forces in the plane Truss shown in Figure below and determine the support reactions also. Take E=200GPa and A= 2000mm^2	Remember	3,1

	 Fig.		
5	For the truss shown in fig.2 determine the a) displacements and b)stresses in the bars .  Fig. 2	Remember	1, 3
6	a) Distinguish between local, natural and global coordinates. b) For the pin jointed configuration shown in Fig.5, determine; i) displacement ii) element stress 3 given ά=10x10^{-6} per 0C ΔT=50^{0}  Fig. 5	Remember	2,3
7	Calculate nodal displacements and element stresses for the members shown in fig. E=200GP$_a$, A=500mm^r, and P=25KN. 	Remember	2,3
8	Determine Nodal displacements and Element stresses in the truss shown in fig. E=80GP$_a$.	Remember	1

Element	Area mm^2	Length mm
1	600	500
2	600	600
3	600	500

			
9	Derive the stiffness matrix for a_a^1 2D truss Element.	Understand	1,3
10	Derive the Stiffness matrix for a 3D truss Element.	Understand	1,2
11	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 elements have E=200GPa, I=5X10^6 mm^4.  **Figure** beam with distributed load	Understand	1,4
12	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	Understand	1
13	Derive the Hermite shape functions for a beam element.	Understand	1,2
14	Draw beam element in global and intrinsic co ordinate system.	Understand	1,2
15	Derive element stiffness matrix for a beam element.	Understand	1,2
16	Derive element stiffness matrix for a truss element in global coordinate system.	Understand	1
17	For the truss shown in fig, solve for the horizontal and vertical components of displacement at node 1 and determine the stress in each element. All elements have A = 500 mm^2 and E = 70 GPa.	Understand	1,2

			
18	Derive stiffness matrix and stress equation for a truss element.	Understand	1,2
19	For the truss element shown below, if q = $[1.5,1.0,2.1,4.3]^{T}x10^{-2}$ in., determine the following: a) The vector q' b) The stress in the element c) The K matrix. 	Understand	1,2
20	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, solve for Q 	Understand	1,2
Analytical Questions			
1	Determine the deflection and slope under the point load for the beam shown in fig given. E=200 GP_a, I= 4 x $10^{-6}m^4$, I_2=2 x $10^{-6}m^4$. 	Understand	1,2

2	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 10^6 N/c,^{2,} I=2500 $cm^{4.}$  	Understand	1,3
3	Determine the nodal displacements and slopes for the beam shown in fig. find the moment at the mid point of element. Take E=200 $GP_{a,,}$ I=5 x 10^4 mm^4, M=6KNM.  	Understand	2,3
4	Determine the nodal displacements and slopes at the position of one-fourth distance from the support of shaft: Take E=200 $GP_{a,,}$ I=6 x $10^4$$mm^{4.}$ The shaft is simply supported at A and B.  	Understand	1
5	Understand the beam shown in Figure below by finite element method and determine the end reactions. Also determine the deflections at mid spans given E=2X10^5N/mm^2, and I=5X10^6 mm^4.  	Understand	3,1

UNIT III - PART I

Short Answer Questions

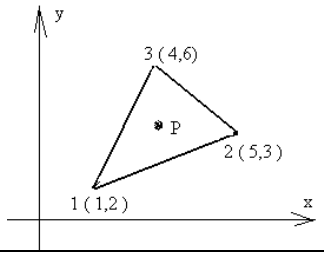
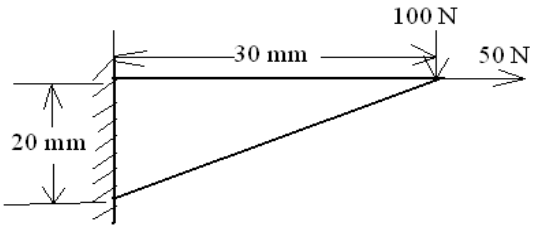
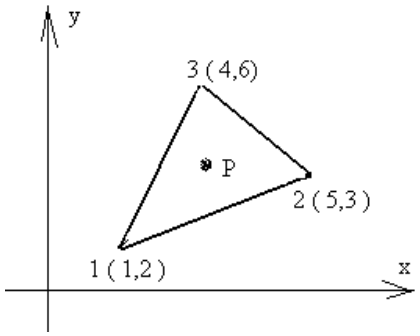
1	What is a two dimensional element.	Understand	2
2	List any four two dimensional elements.	Understand	2
3	Enumerate some of the remembers of 2-D elements.	Understand	2
4	What do you mean by discretizing of 2-D elements.	Understand	2
5	Define shape function.	Understand	2, 3
6	What is the condition for number of unknown polynomial coefficients of a 2-D element?	Understand	2
7	Express the 2-D element in polynomial series.	Understand	2, 3

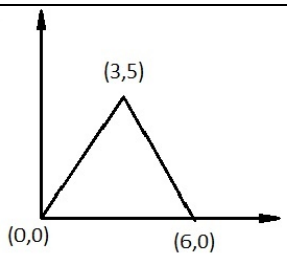
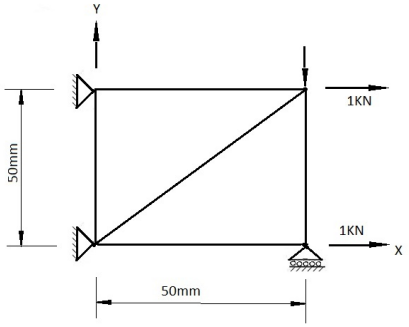
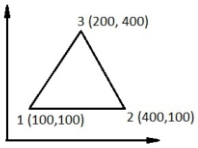
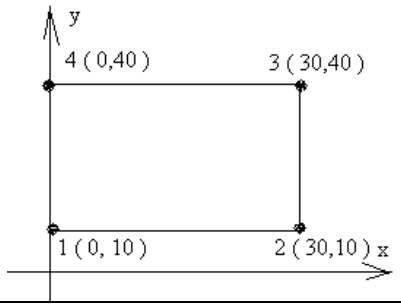
8	What is a CST element?	Understand	2, 3
9	What is LST element?	Understand	2
10	Represent the node numbering of Constant strain triangle element.	Understand	2, 3
11	Represent the node numbering of Linear strain triangle element.	Remember	2
12	Define Quadratic triangle.	Understand	2, 3
13	Write the expression for displacements developed in the X-direction of CST element.	Understand	2
14	Write the expression for displacements developed in the X-direction of LST element.	Remember	2, 3
15	Write the expression for displacements developed in the Y-direction of CST element.	Understand	2, 3
16	Write the expression for displacements developed in the Y-direction of LST element.	Understand	2
17	What is a linear element?	Understand	2, 3
18	What is a nonlinear element?	Understand	2
19	Differentiate between linear and non linear elements.	Understand	2, 3
20	What type of nodes of considered for Linear elements?	Understand	3
21	What type of nodes of considered for non-Linear elements?	Understand	2
22	Express the shape functions of CST triangle.	Understand	2, 3
23	Draw the shape functions of CST triangle.	Understand	3
24	Draw the element connectivity table of a CST triangle.	Understand	2

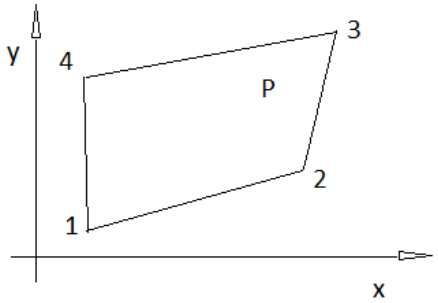
Long Answer Questions

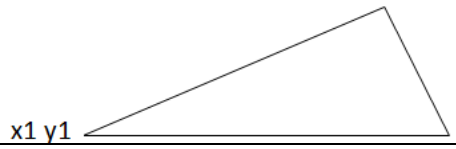
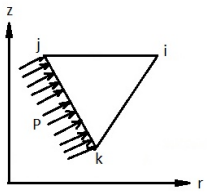
UNIT III - PART I

1	a) formulate the finite element equations for contant strain triangle as shown in fig 1.1.Assume plane stress, E=200Gpa,v=0.25,thickness=5mm,nodal co-ordinates X1=1 X2=5 X3=3 Y1=2 Y2=4 Y3=6 Pressure on 1-2 edge is 5N/mm2 b) calculate the element stress for the element shown in fig1.2 for the plain strain condition.Displacement vector given as [q]=[0 0 0.001 0.002 -0.003 0.002] mm, E=200Gpa,v=0.25,thickness=20mm α=2x10-6 per 0c ΔT=50 deg c X1=0 X2=250 X3=250 Y1=0 Y2=0 Y3=250	Understand	2, 3

2	Formulate the finite element equations for the element shown in fig2.1 E=200Gpa,ν.=0.3,thickness=5mm,p_1=5N/mm^2 acting on side jk and along x –direction P_2=2N/mm^{2}acting along on the side and perpendicular to the side ik.use plane stress condition. X_i =1, X_j=6, X_k=3 Y_i=1, Y_j=4, Y_j=5 	Understand	2, 3
3	a).Explain Iso-parametric, sub-parametric and super-parametric elements b) Advantages of iso-parametric elements c) Write short notes on Gaussian quadrature integration technique	Understand	2, 3
4	Derive the strain displacement matrix for triangular element.	Understand	2
5	For the configuration shown in figure, determine the deflection at the point load remember Using a one element model. T = 10 mm , E = 70 G Pa ,ν = .3 	Understand	2, 3
6	a) Explain Convergence requirements. b) The Nodal Coordinates of the triangular elements is shown in fig: At the interior point P, the x-coordinate is 3.3 and N_1 = 0.3. Determine N_1N_2 and the y-coordinate of point P. 	Understand	2, 3
7	a) Evaluate the integral I=$\int\int (2x^2 + 3xy + 4y^2)$dx dy in the limits of -1 to +1 using gauss quadrature numerical integration b) Verify with exact solution.	Understand	2
8	Evaluate the element stiffness matrix for the triangular element shown in fig. under plance strain condition. Assume the following values. E=200 GP_a, μ=0.25, t=1 mm.	Understand	2, 3

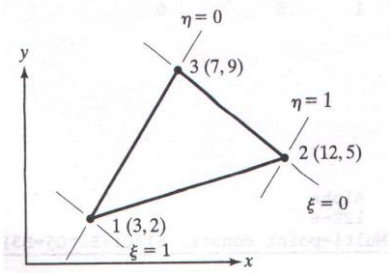
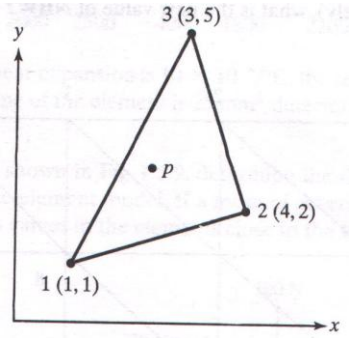
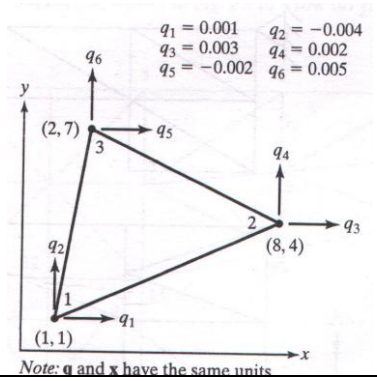
			
9	For the plane stress element shown in fig. the nodal displacement are μ_1=2.0mm; V_1=1.0; μ_2=1.0mm; V_2=1.5mm; μ_3=2.5mm; V_3=0.5mm. Determine the element stresses. Assume E=200 GN/m^2; μ=0.3; t=10  mm.	Understand	2, 3
10	Determine the nodal displacements and element stresses for the two dimensional loaded plate as shown in fig. assumes plane stress conditions. Body force may be neglected in comparison to the external forces. Take E=210 GP$_a$, μ=0.25; thickness = 10mm. 	Understand	2, 3
11	a)A four node quadrilateral element is shown in fig 1.3.the co ordinates of each node are given in cm.The element displacement vector is given as [q]=[0 0 0.2 0 0.15 0.10 0 0.05] cm. Determine (i) the x, y co-ordinates of a point P whose location at ξ =0.5,η=0.5 (ii) the displacement of point P(u,v) (iii)the jacobian at P b) Evaluate the Integral I= $\int_{-1}^{1}$ ($3\xi^2+\xi^3$) dξ using Gaussian quadrature method.	Understand	2, 3
	UNIT III - PART II		
12	Determine the shape functions for a 8 node quadratic quadrilateral element (boundary noded).	Understand	2, 3
13	For the element shown in the figure, assemble Jacobian matrix and strain displacement matrix 		

<table>
<tr><td>14</td><td>Derive the a)shape function and b) strain displacement matrices for triangular element of revolving body</td><td>Understand</td><td>2, 3</td></tr>
<tr><td>15</td><td>For the Isoparametric quadrilateral element shown in fig , determine the local co-ordinates of the point P whose Cartesian co=ordinates as(6,4)
 

<table>
<tr><td>node</td><td>x</td><td>y</td></tr>
<tr><td>1</td><td>2</td><td>1</td></tr>
<tr><td>2</td><td>5</td><td>2</td></tr>
<tr><td>3</td><td>7</td><td>6</td></tr>
<tr><td>4</td><td>1</td><td>5</td></tr>
</table></td><td>Understand</td><td>2, 3</td></tr>
<tr><td>16</td><td>A triangular membrane element of thickness=0.1cm with the x,yco ordinates of the nodes indicated node numbers as shown in the figure. if the material of the element is steel with young’s modulus E=207 Gpa and poisons ratio=0.3.Determine the following.
a)shape functions of the element N1,N2 &N3
b)strain displacement matrix ,B
c) Elasticity matrix D for plane stress condition
d)element stiffness matrix
x1=1 y1=3
x2=5 y2=4
x3=4 y3=7
 
</td><td>Understand</td><td>2, 3</td></tr>
<tr><td>17</td><td>Explain the concept of numerical integration and its utility in generating Isoperimetric finite element matrices.</td><td>Understand</td><td>2, 3</td></tr>
<tr><td>18</td><td>Explain the concept of numerical integration and its utility in generating Isoperimetric finite element matrices.</td><td>Understand</td><td>2, 3</td></tr>
<tr><td>19</td><td>b) evaluate the integral I=∫ ∫ $(3x^3 + 2xy + 7y^3)$dx dy in the limits of -1 to +1 using gauss quadrature numerical integration and verify with exact solution.</td><td>Understand</td><td>2, 3</td></tr>
<tr><td>20</td><td>Formulate element equations for the axi-symmetric element shown in fig. E=100 GP_a, μ=0.3 α=5 x 10^{-6} Pic^0C.
$\Delta T = 60^0 C$
P=8N/mm^2 acting perpendicular to side jk
Nodal co-ordinates
r_i = 5, rj = 1, r_k = 3,
z_i = 5, z_i = 5, z_k = 2,
 
</td><td>Understand</td><td>2, 3</td></tr>
</table>

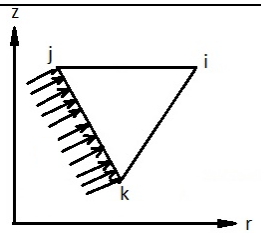
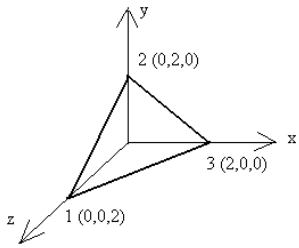
Analytical Questions

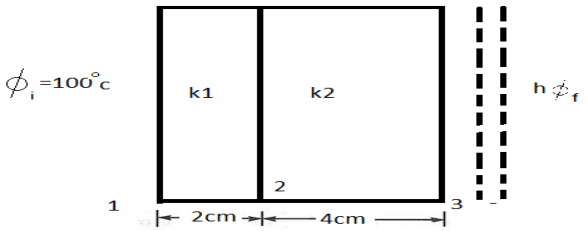
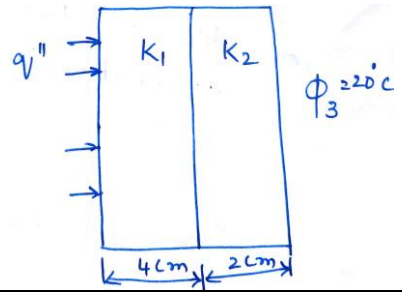
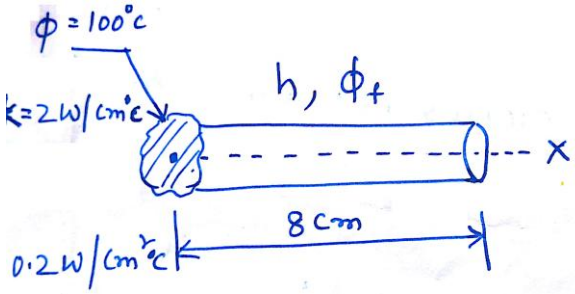
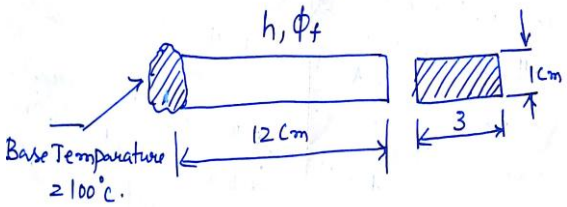
UNIT III - PART I

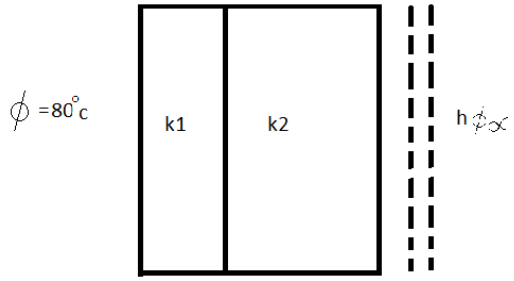
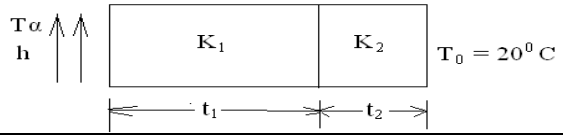
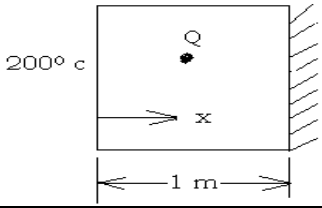
1	Determine the jacobian for the (x, y) – (ξ, η) transformation for the element shown in fig, also find the area of the triangle. 	Understand	2
2	For the point P located inside the triangle, the shape functions N_1 and N_2 are 0.15 and 0.25, respectively. Determine the x and y coordinate of P. 	Understand	2
3	For the triangular element shown in fig, obtain strain-displacement relation matrix B and determine the strains ε_x, ε_y and γ_{xy}.  *Note:* **q** and **x** have the same units	Understand	2, 3

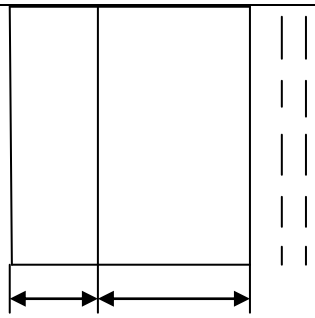
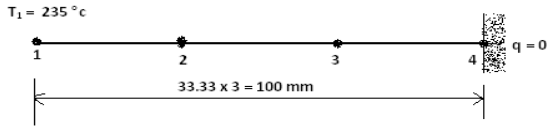
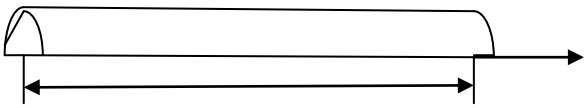
UNIT III - PART II

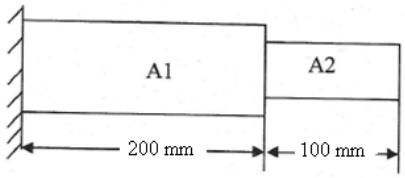
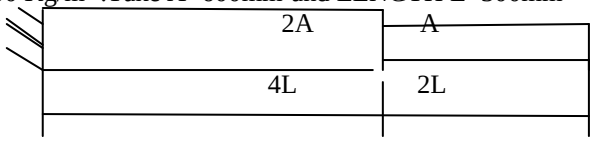
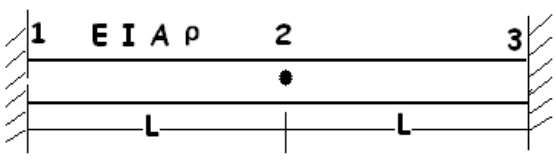
4	Formulate the element equations for axi-symetric element shown in fig node R z i 5 5 j 1 5 k 3 2 E=100Gpa, ν =0.3 ά 5 x10 -6 per deg C ΔT=60 deg p=8N/mm2 acting perpendicular to jk side	Understand	2, 3

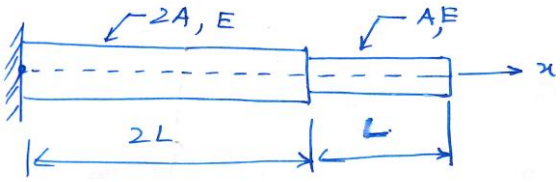
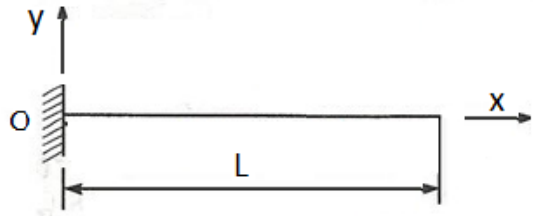
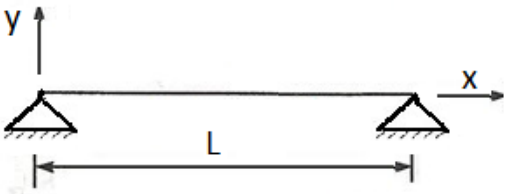
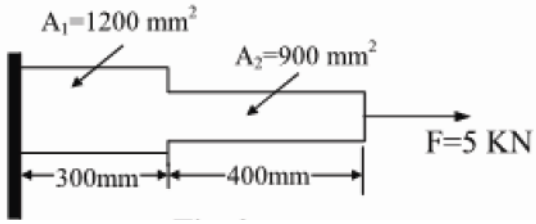
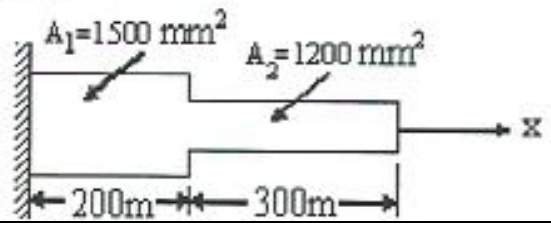
			
5	Determine the strain displacement matrix for the TETRAHEDRAL element as shown in fig 	Understand	2, 3
	UNIT – IV		
	Short Answer Questions		
1	What is conduction?	Remember	3
2	Define fins or extended surfaces	Understand	3
3	State the remembers of fins.	Remember	3
4	Discuss the types of heat transfer	Remember	3
5	What is Convection?	Understand	3
6	What is radiation?	Understand	3
7	What is Fourier's law?	Understand	3
8	What is Newton's law of cooling?	Understand	3
9	What is Stefan-Boltzmann law?	Remember	3
10	Write the basic equation of heat transfer.	Remember	3
Long Answer Questions			
1	Derive thermal stiffness matrix for one dimensional heat conduction with lateral surface convection and with internal heat generation.	Understand	3, 4
2	Describe heat transfer analysis for composite wall.	Understand	3, 4
3	Describe heat transfer analysis for straight fin	Understand	3, 4
4	Derive the Strain displacement Matrix for 2D-Thin plate. Consider the temperature field with in the triangular element is given by $T= N_1T_1 + N_2T_2 + N_3T_3$.	Understand	3, 4
5	Describe heat transfer analysis for tapered fin.	Understand	3, 4
6	Determine the nodal temparatures in a composite wall shown in fig. the wall in maintained at 100^0C at the left face and convection mode of heat transfer occurs between the right fare and the existing fluwd. Thermal conduction K_1=0.06W/cm^{0}C, K_2=0.2 W/Cm^{0}C, Convection co-efficient of heat transfer between walls and fluid h=0.1W/cm^2 0^0C and $Ø_f=25^0$C. Consider unit area A=1cm^2 perpendicular to the direction of heat flow.	Understand	3, 4

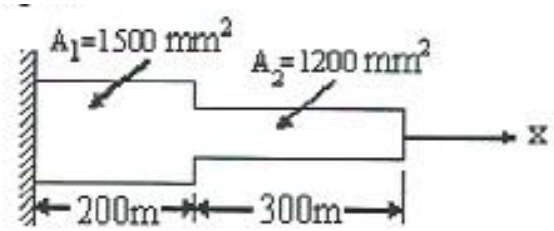
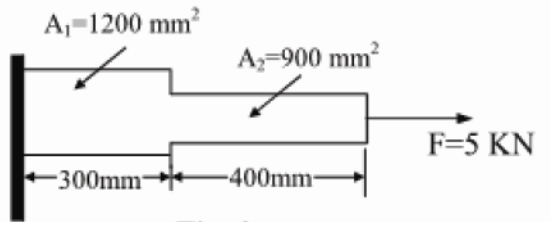
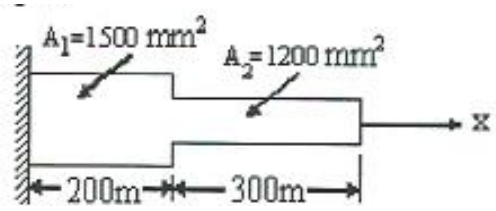
			
7	Determine the temperature at the nodal interfaces for the two layered wall shown in fig. the left face is supplied with heat flux of q^{11}=5w/cm^2 and right face in main fained at 20^{0}C. Q^u=5w/cm^2 K_1=0.2W/cm^{0}C K_2=0.06W/cm^{0}C A=1cm^2. 	Understand	3, 4
8	Determine the temperature distribution in a fig of circular goss-section shown in fig. Base of the fin in maintained at 100^{0C} and tip of the fin is insulated. Thermal conductivity K=2w/cm^{0}C, Convective heat transfer co-efficient h=0.2w/cm^2, $Ø_f$=20^{0}C (fluid temperature) and Diameter of the fin=1cm. 	Understand	3
9	Calculate the nodal temperature using one dimensional analysis of a fin as shown in fig. The fin has rectangular cross-section. Assume that the tip of the fin in insulated. Solve the problem i. 2 Linear elements ii. 3 Linear elements iii. 4 Linear elements and compare nodal temparatures. Thermal conductivity K=4w/cm^{0}C, Convective heat transfer co-efficient h=0.1w/cm^2 ^{0}C and Adjacent fluid temperature $Ø_f$=25^{0}C. 	Understand	3
10	Determine the nodal temparatures and rate of heat transfer through a composite wall shown in fig. Thermal conductivities K_1=45w/m^{0}C and K_2=0.5w/m ^{0}C. Convective heat transfer co-efficient h=20w/m^2 ^{0}C, Temparature of left face of wall =80^{0}C and Ambient temperature $Ø_\alpha$=25^{0}C. Assume the area normal to the direction of heat flow =1cm^2.Use linear elements.	Understand	3

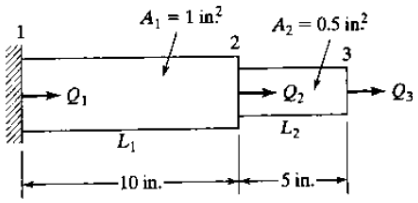
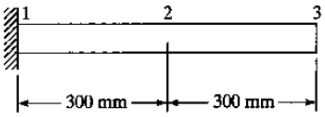
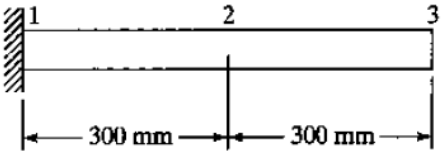
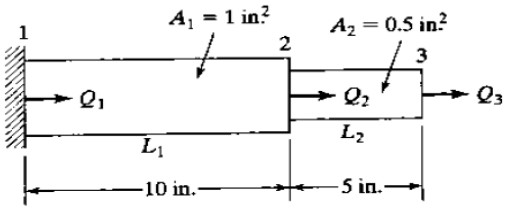
			
11	Write down the differential equations of 1D steady state heat conduction problem.	Understand	3, 4
12	What are different types of boundary conditions for 1D heat conduction problems?	Understand	3
13	Obtain the functional approach of finite element equations for a one dimensional heat conduction problem.	Understand	3, 4
14	Derive one dimensional steady state heat conduction equation.	Understand	3, 4
15	Compare the finite element formulations of structural problems with heat transfer problems.	Understand	3
16	Derive one dimensional steady state heat conduction equation and understand to one dimensional fin problem	Understand	3, 4
17	Explain the methodology for the treatment of all three boundary conditions in a 1-D heat transfer element?	Understand	3
18	Derive element equations for a one dimensional heat conduction element by considering the weak form.	Understand	3
19	Derive the conductivity matrix and thermal load vector for the one dimensional finite element for the three boundary conditions.	Understand	3
20	Give a brief description of steady state problems.	Understand	3, 4
	Analytical Questions		
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	3, 4
2	The plane wall shown in fig. The thermal conductivity K = 25W/m^{0}c and there is a uniform generation of heat in the wall of Q = 400W/m^3. Determine the temperature distribution at five nodes (include two sides of the walls) in equal distances through the wall thickness. 	Understand	3, 4
3	Determine the nodal temperature in a composite wall shown in fig 1.4.the wall is mainted 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 deg c and k_2=0.2w/cm deg c. convection co efficient of heat transfer between walls and fluid h=0.1w/cm^{2}deg c and T_∞=25 deg c.consider unit area=1 cm^2 perpendicular to the direction of heat flow.	Understand	3, 4

			
4	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	3, 4
5	Determine the temperature distribution in a fin of circular cross section shown in fig1.5.considering two elements,base of the fin is maintained at 100 deg c and tip of the fin is insulated. Thermal conductivity k=2w/cm deg c. Convective heat transfer co-efficient is h=0.2w/cm^{2}deg c. Fluid temperature T_∞20 DEG C,DIAMETRE OF THE FIN=1cm. length=8cm 	Understand	3, 4
UNIT – V			
Short Answer Questions			
1	What is lumped mass matrix?	Understand	2
2	What is consistent mass matrix?	Understand	2
3	Define Eigen values?	Understand	2
4	What is meant Eigen Vectors?	Understand	2
5	Write the expression for element mass matrix for a bar element?	Understand	2, 3
6	Write the expression for element mass matrix for a truss element?	Understand	2
7	Write the expression for element mass matrix for a CST element?	Understand	2, 3
8	Write the mass matrix for truss element with an example.	Understand	2, 3
9	Write the expression for modal analysis of bar and beam elements.	Understand	2
10	What are the convergence requirements in finite element modeling?	Understand	2, 3
11	List some software packages of FEA.	Remember	2

12	What are the important steps in ANSYS.	Understand	2, 3
13	Give some practical problems associated with finite element modelling.	Understand	2
14	What is the difference between h-method and p-method.	Remember	2, 3
15	Write the importance of element selection in fem.	Understand	2, 3
16	Write the importance of boundary conditions in finite element modelling.	Understand	2
17	List out factors influencing the accuracy of the results	Understand	2, 3
18	Define free meshing.	Understand	2
19	Define mapped meshing.	Understand	2, 3
20	What is meant by pre processing?	Understand	3
	Long Questions		
1	Evaluate natural frequencies for the stepped bar shown fig. in axial vibration take E=200 GPa and DENSITY= 7850 Kg/m^3.b)Draw mode shapes and determine Eigen vector .Take A_1=400mm^2 and A_2=200mm^2 using characteristic polynomial method. 	Understand	2, 3
2	Explain the following with examples: a) Lumped parameter model. b) Continuous system model.	Understand	2, 3
3	Evaluate natural frequencies for the canti lever beam using one element.	Understand	2, 3
4	a)Evaluate natural frequencies for the stepped bar shown in fig b)corresponding eigenvectors and mode shapes. take E=200Gpa and density 7500 Kg/m^3 .Take A=600mm^{2}and LENGTH L=300mm 	Understand	2, 3
5	a)Determine the eigen values and the associated Eigen vectors of the matrix [A] given by $A = \begin{bmatrix} 3 & 4 \\ 4 & -3 \end{bmatrix}$ b) State the properties of Eigen Values.	Understand	3, 4
6	Determine the Natural frequency of the beam shown in the figure. 	Understand	3, 4
7	Derive the eigen value eigen vector and mode shapes of the given	Understand	3, 4

	stepped bar element. When L=length; A=Area of cross-section E=Modules of electivity and Ƥ=Density of the material. 		
8	Derive Approximate the first two natural frequencies of a cantilever beam using one element model. EI=Flexural rigidity. 	Understand	3, 4
9	Determine the approximate first two natural frequeneves of a simply supported beam using on a element. Flexural Rigidity =EI; Density = Ƥ Cross-sectional area=A 	Understand	3, 4
10	Distinguish between consistent mass matrix and lumped mass matrices.	Understand	3, 4
11	Determine the mass matrix for truss element with an example. Consider axial vibration of the Aluminium bar shown in Figure below, a. Develop the global stiffness and b. 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	3, 4
12	Differentiate between Consistent Mass matrix and Lumped Mass matrix	Understand	3, 4
13	Consider axial vibration of the steel bar shown in Figure below, a. Develop the global stiffness and mass matrix and b. Determine the natural frequencies and mode shapes using the characteristic polynomial technique. 	Understand	3, 4
14	Derive the elemental mass matrix for 1-D bar element and 1-D plane truss element.	Understand	3, 4
15	Explain the following with examples:	Understand	3, 4

	a. Lumped parameter model. b. Continuous system model.		
16	From first principles, derive the general equation for elemental mass matrix?	Understand	3, 4
17	Determine the natural frequencies and mode shapes of a stepped bar shown in figure below using the characteristic polynomial technique. Assume E=300GPa and density is 7800 Kg/m^3.	Understand	3, 4
18	State the method used for obtaining natural frequencies and corresponding eigen vectors.	Understand	3, 4
19	Determine the natural frequencies and mode shapes of a stepped bar shown in figure below using the characteristic polynomial technique. Assume E=300GPa and density is 7800 Kg/m^3. 	Understand	3, 4
20	Consider axial vibration of the Aluminium bar shown in Figure below, a. Develop the global stiffness and b. 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	3, 4
	Analytical Questions		
1	Consider axial vibration of the steel bar shown in Figure below develop the global stiffness and mass matrix and determine the natural frequencies and mode shapes using the characteristic polynomial technique 	Understand	2, 3
2	Determine the Eigenvalues and Eigenvectors for the stepped bar shown in Figure below.	Understand	2, 3

	 $E = 30 \times 10^6$ psi Specific weight $f = 0.283$ lb/in.^{3}		
3	Evaluate the lowest Eigenvalue and the corresponding Eigenmode for the beam shown in Figure below  $E = 200$ GPa $\rho = 7840$ kg/m^3 $I = 2000$ mm^4 $A = 240$ mm^2	Understand	2, 3
4	Evaluate the lowest Eigenvalue and the corresponding Eigenmode for the beam shown in Figure below.  $E = 200$ GPa $\rho = 7840$ kg/m^3 $I = 2000$ mm^4 $A = 240$ mm^2	Understand	2, 3
5	Determine the Eigenvalues and Eigenvectors for the stepped bar shown in Figure below.  $E = 30 \times 10^6$ psi Specific weight $f = 0.283$ lb/in.^{3}	Understand	2, 3

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