INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad-500043

CIVIL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**ADVANCED STRUCTURAL ANALYSIS**				
Course Code	BSTB01				
Programme	M.Tech				
Semester	I	STE			
Course Type	Core				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Dr. Venu M, Professor				
Course Faculty	Dr. Venu M, Professor				

COURSE OBJECTIVES:

The course should enable the students to:	
I	Analyze the skeleton structures using stiffness analysis code.
II	Use direct stiffness method understanding its limitations.

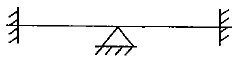
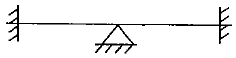
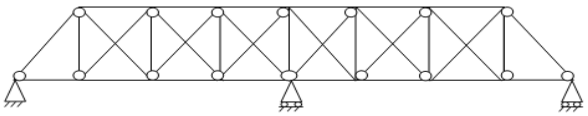
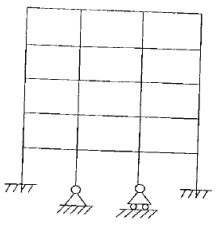
COURSE OUTCOMES (COs):

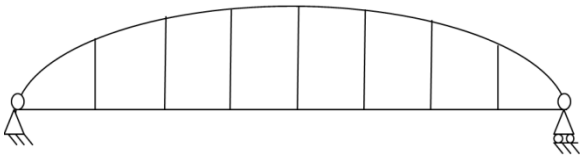
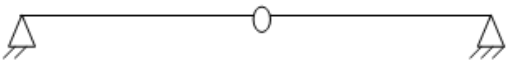
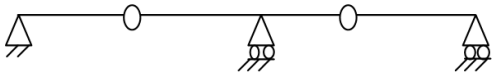
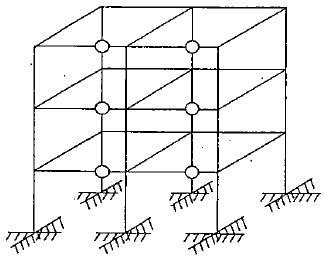
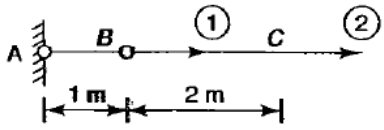
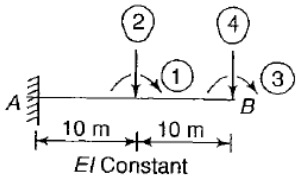
CO 1	Know the physical significance, effects of settlements, temperature change and lack of fit, member approach and structure approach.
CO 2	Understand the force method and displacement method, degree of freedom,local coordinates and global coordinates.
CO 3	Understand the stiffness matrix in global coordinates, boundary conditions, solution of stiffness matrix equations, calculation of reactions and member forces for beams, plane trusses, plane rigid jointed frames and grids by structure approach and member approach.
CO 4	Know the boundary value problems: approximate solution of boundary value problems, modified galerkin method for one-dimensional BVP, matrix formulation of the modified galerkin method.
CO 5	Understand the shape functions linear element, solution for poisson's equation, general one dimensional equilibrium problem.

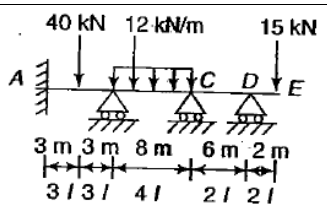
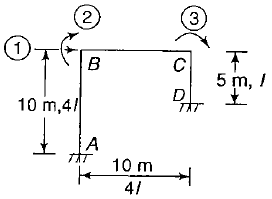
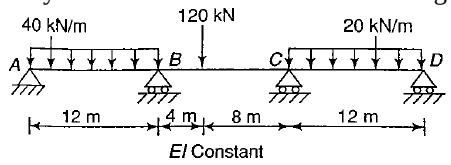
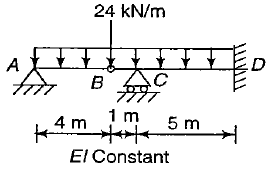
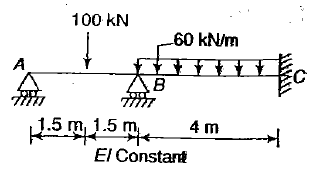
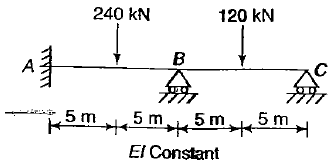
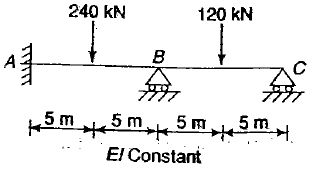
COURSE LEARNING OUTCOMES (CLOs):

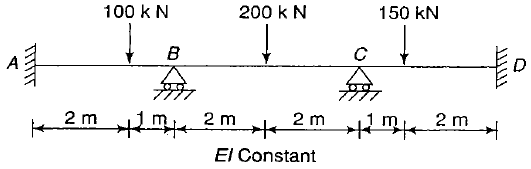
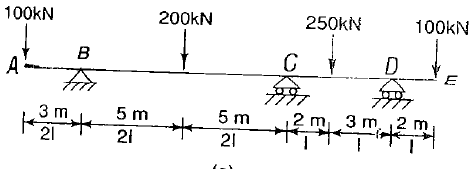
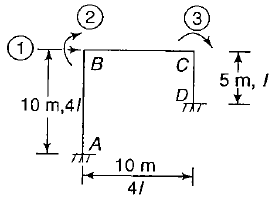
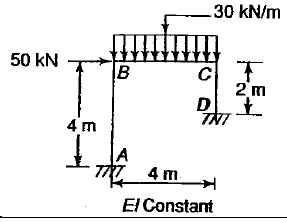
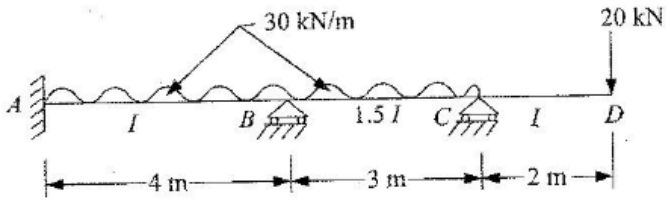
BSTB01.01	Understand the physical significance of stiffness influence coefficients.
BSTB01.02	Understand the effects of settlements of stiffness influence coefficients.
BSTB01.03	Solve the problems on temperature change and lack of fit.
BSTB01.04	Know the member approach and structure approach.
BSTB01.05	Understand the force method.
BSTB01.06	Understand the displacement method.
BSTB01.07	Know concept of degree of freedom.
BSTB01.08	Understand the concept of local coordinates.
BSTB01.09	Understand the concept of global coordinates.
BSTB01.10	Develop the stiffness matrix for global coordinates and know the boundary conditions.
BSTB01.11	concepts on solution of stiffness matrix equations.
BSTB01.12	Know the calculation of reactions and member forces.
BSTB01.13	Understand the stiffness method for beams, plane trusses and plane rigid jointed frames.
BSTB01.14	Understand the formulation of grid structures.
BSTB01.15	Concept of structure and member approach.
BSTB01.16	Understand the solutions for boundary value problems.
BSTB01.17	Know the modified galerkin method.
BSTB01.18	Understand the modified galerkin method for one-dimensional BVP.
BSTB01.19	Understand the matrix formulation of the modified galerkin method.
BSTB01.20	Know the shape functions for linear elements.
BSTB01.21	Understand the solution for poisson’s equation.
BSTB01.22	Formulation of general one dimensional equilibrium problem.
BSTB01.23	Solution of general one dimensional equilibrium problem.

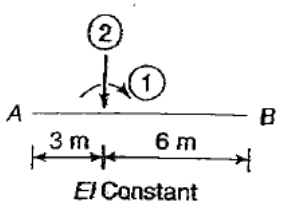
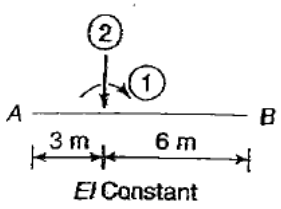
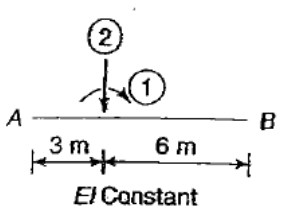
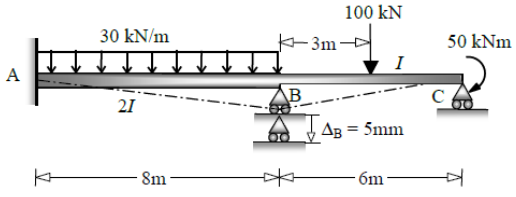
TUTORIAL QUESTION BANK

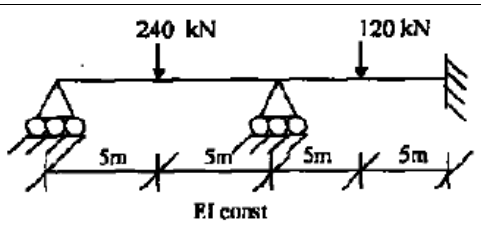
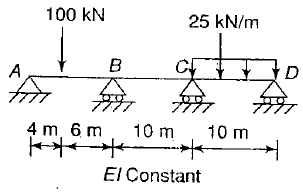
	UNIT- I			
	INFLUENCE COEFFICIENTS			
	Part - A (Short Answer Questions)			
S. No.	**QUESTIONS**	**Blooms Taxonomy Level**	**Course Outcomes**	**Course Learning Outcomes (CLOs)**
1	Distinguish between static and kinematic indeterminacy.	Remember	CO 1	BSTB01.01
2	Differentiate between determinate and indeterminate structures.	Understand	CO 1	BSTB01.01
3	Define stiffness.	Remember	CO 1	BSTB01.01
4	Define internal and external indeterminacies.	Remember	CO 1	BSTB01.01
5	Distinguish between plane truss and space truss.	Remember	CO 1	BSTB01.02
6	What is transformation matrix?	Remember	CO 1	BSTB01.02
7	Find the degree of redundancy for a propped cantilever beam and a fixed beam.	Remember	CO 1	BSTB01.02
8	State the conditions of equilibrium.	Remember	CO 1	BSTB01.02
9	Find the static indeterminacy of beam shown below. 	Remember	CO 1	BSTB01.02
10	Find the kinematic indeterminacy of beam shown below. 	Remember	CO 1	BSTB01.02
	Part - B (Long Answer Questions)			
1	Derive the stiffness influence coefficients of prismatic member AB by giving a unit displacement i.e. slope at A and B.	Understand	CO 1	BSTB01.01
2	Derive the stiffness influence coefficients of prismatic member AB by giving a unit displacement i.e. deflection at A and B.	Understand	CO 1	BSTB01.01
3	Derive the stiffness influence coefficients of prismatic member AB by giving a unit axial displacement at A and B.	Understand	CO 1	BSTB01.01
4	Determine the degree of redundancy for the following structures: (a)  (b) 	Understand	CO 1	BSTB01.02
5	Formulate the stiffness matrices for a cantilever beam and fixed beam.	Understand	CO 1	BSTB01.02
6	What is the degree of kinematic indeterminacy for a simply supported beam? If the effects of axial deformations are neglected, what is the degree of kinematic indeterminacy?	Understand	CO 1	BSTB01.02

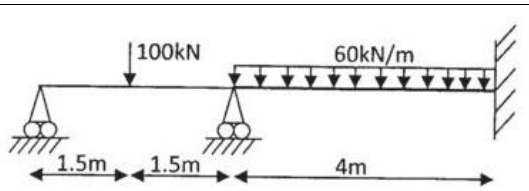
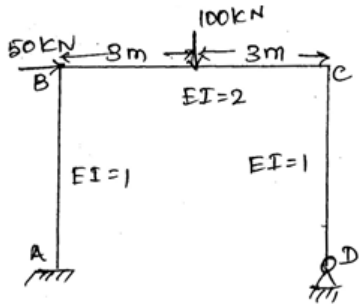
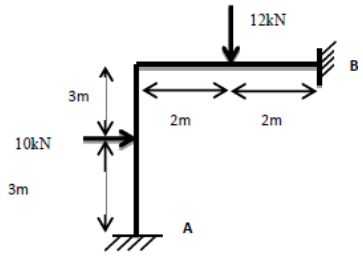
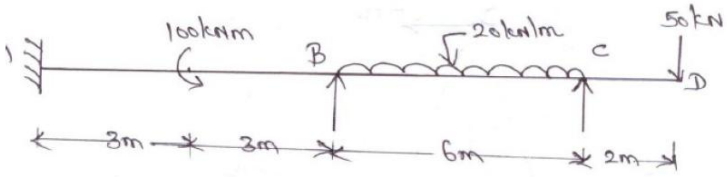
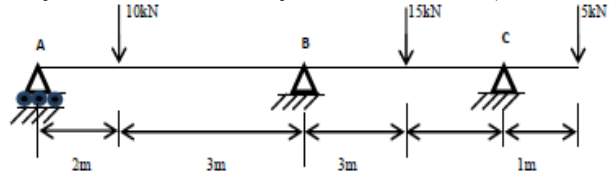
7	Determine the degree of static and kinematic indeterminacy for the following structures: 	Understand	CO 1	BSTB01.01
8	Which of the beams are statically determinate? For these beam, calculate the degrees of redundancy.  (a)  (b)	Understand	CO 1	BSTB01.03
9	Determine the degree of static indeterminacy for the following structure. 	Understand	CO 1	BSTB01.03
10	Two steel bars AB and BC, each having a ross sectional are of 20mm2, are connected in series as shown in figure. Develop the flexibility and stiffness matrices with reference to coordinates 1 and 2 shown in the figure. Verify that the two matrices are the inverse of each other. Take E = 200kN/mm2. 	Understand	CO 1	BSTB01.04
	Part - C (Problem Solving and Critical Thinking Questions)			
1	Develop the stiffness matrices for a beam AB with reference to the coordinates shown in figure. 	Understand	CO 1	BSTB01.03
2	Analyze the continuous beam shown in figure using stiffness method	Analyze	CO 1	BSTB01.03

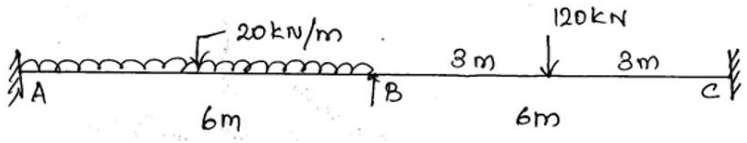
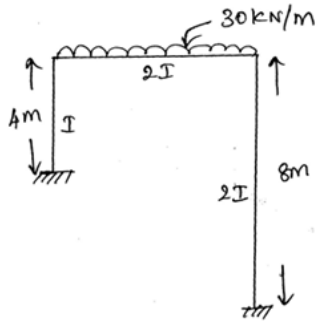
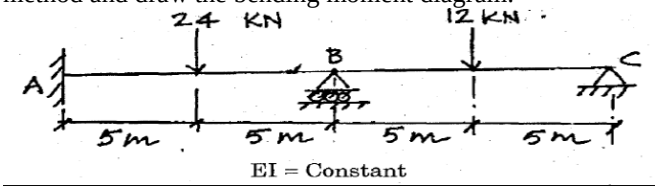
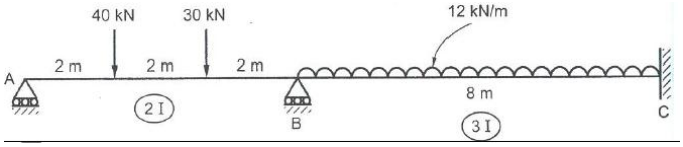
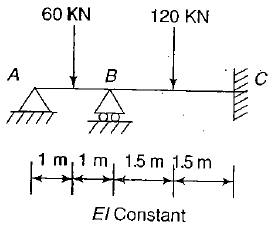
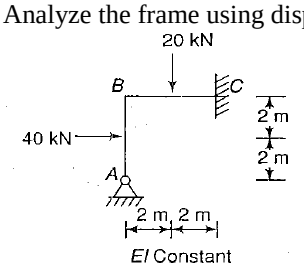
				
3	Develop the stiffness matrix for portal frame ABCD with reference to the coordinates shown in figure. 	Analyze	CO 1	BSTB01.04
4	Analyze the continuous beam shown in figure using stiffness method. 	Analyze	CO 1	BSTB01.03
5	Analyze the continuous beam shown in figure using stiffness method. 	Analyze	CO 1	BSTB01.03
6	Analyze the continuous beam shown in figure using stiffness method. 	Analyze	CO 1	BSTB01.04
7	Analyze the continuous beam shown in figure using stiffness method. 	Analyze	CO 1	BSTB01.04
8	Analyze the continuous beam shown in figure using stiffness method, if the downward settlement of supports B and C in kN-m units are 2000/EI and 1000/EI respectively. 	Analyze	CO 1	BSTB01.04

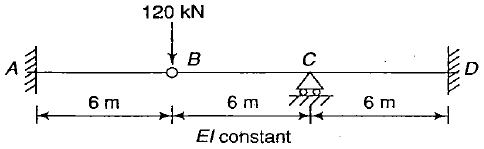
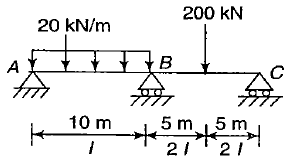
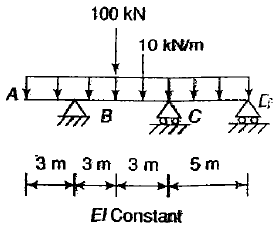
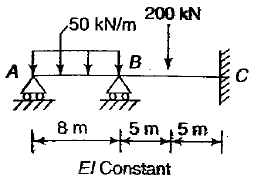
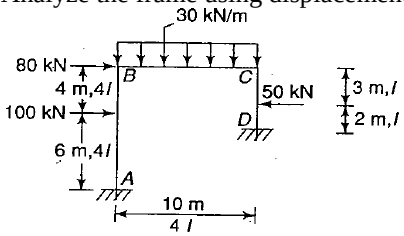
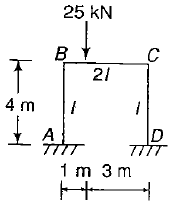
9	Analyze the continuous beam shown in figure using stiffness method. 	Analyze	CO 1	BSTB01.03
10	Analyze the continuous beam shown in figure using stiffness method. 	Analyze	CO 1	BSTB01.04
	UNIT-II			
	STIFFNESS METHOD APPLIED TO LARGE FRAMES			
	Part – A (Short Answer Questions)			
1	Define flexibility coefficient.	Understand	CO 2	BSTB01.05
2	What do mean by force or flexibility method?	Understand	CO 2	BSTB01.05
3	What is the relationship between flexibility and stiffness equations?	Understand	CO 2	BSTB01.05
4	Is it possible to develop a flexibility matrix for a determinate structure?	Understand	CO 2	BSTB01.05
5	Write the relation between flexibility and stiffness.	Remember	CO 2	BSTB01.05
6	Find the static and kinematic indeterminacy of a fixed beam.	Understand	CO 2	BSTB01.06
7	Find the static and kinematic indeterminacy of a propped cantilever beam.	Remember	CO 2	BSTB01.06
8	Calculate the static indeterminacy of a continuous beam ABC of two spans of support A is fixed and B,C are simply supported.	Understand	CO 2	BSTB01.06
9	Find the static and kinematic indeterminacy of a cantilever beam.	Understand	CO 2	BSTB01.07
10	Find the static and kinematic indeterminacy of a two side overhanging beam.	Understand	CO 2	BSTB01.07
	Part - B (Long Answer Questions)			
1	Develop the stiffness matrix for the frame shown in figure. 	Analyze	CO 2	BSTB01.05
2	Analyze the frame using stiffness method. 	Analyze	CO 2	BSTB01.05
3	Analyze the continuous beam shown in figure using stiffness method. 	Analyze	CO 2	BSTB01.05

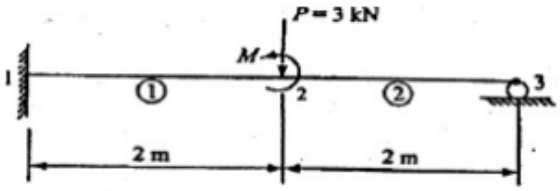
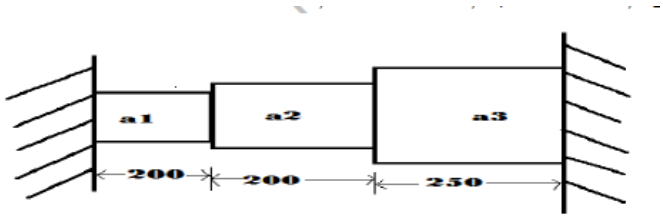
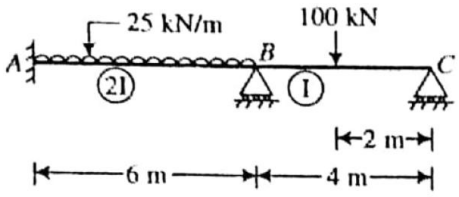
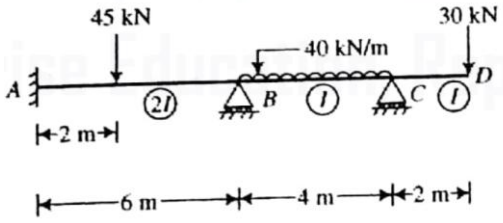
4	Develop the stiffness matrix for a prismatic member AB with reference to the coordinates shown in figure with hinged support at A and roller support at B. 	Understand	CO 2	BSTB01.05
5	Develop the stiffness matrix for a prismatic member AB with reference to the coordinates shown in figure with fixed supports at A and B. 	Understand	CO 2	BSTB01.05
6	Develop the stiffness matrix for a prismatic member AB with reference to the coordinates shown in figure with fixed support at A and roller support at B. 	Understand	CO 2	BSTB01.05
7	Write the similarities and dis-similarities of force method and displacement method.	Understand	CO 2	BSTB01.06
8	What is relationship between stiffness matrix and flexibility matrix?	Understand	CO 2	BSTB01.07
9	A two span continuous beam ABCD is fixed at A and hinged at support B and C. span of AB =Span of BC =9m. Arrange the stiffness influence co-efficient matrix assuming vertical reaction at B and C as redundant.	Understand	CO 2	BSTB01.08
10	Explain the procedure of analysis using force and displacement method.	Understand	CO 2	BSTB01.05
Part - C (Problem Solving and Critical Thinking Questions)				
1	Analyze the two-span continuous beam shown in Figure by any matrix method (stiffness method) and draw the bending moment diagram. Assume EI = 27000 kNm^2. 	Analyze	CO 2	BSTB01.06
2	Analyze the continuous beam by direct stiffness method.	Analyze	CO 2	BSTB01.05

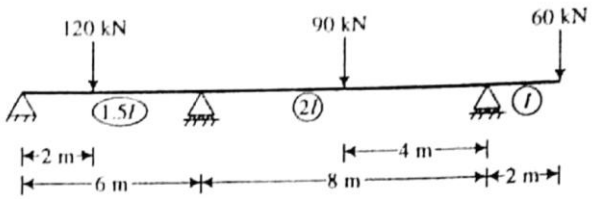
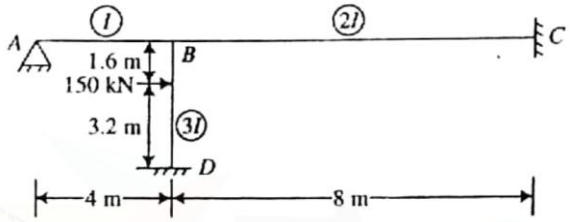
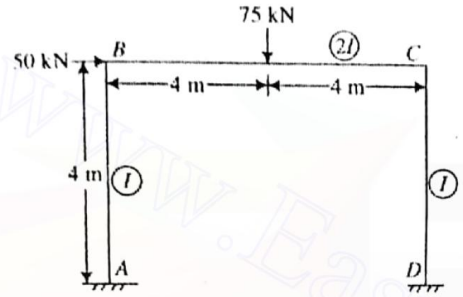
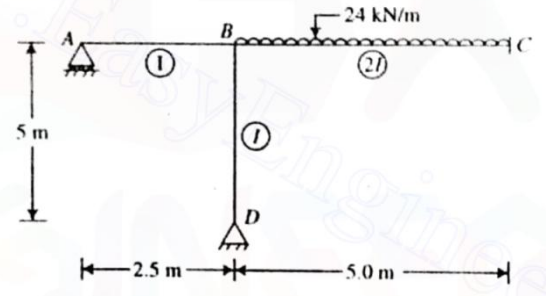
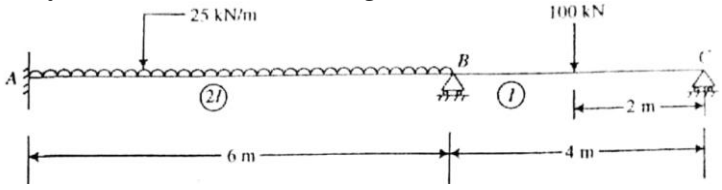
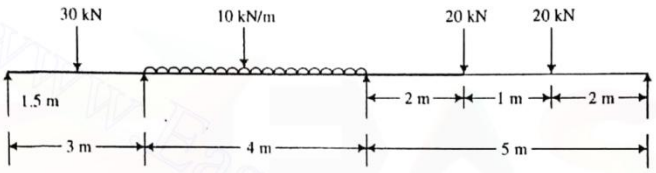
				
3	A two span continuous beam ABC is fixed at A and simply supported over the supports B and C. AB=6m and BC = 4m. Moment of inertia is constant throughout. A uniformly distributed load of 2 Ton/m acts over AB and a single concentrated load of 6 tons acts on BC. Estimate BM by stiffness matrix method.	Analyze	CO 2	BSTB01.06
4	Write down the step by step procedure for the direct stiffness method of analysis for trusses.	Understand	CO 2	BSTB01.07
5	Derive the equation for stiffness matrix in local coordinates for a truss member.	Understand	CO 2	BSTB01.07
6	Explain the assembly of global and local coordinates for formulation of transformation force and displacement matrices.	Understand	CO 2	BSTB01.08
7	A portal frame ABCD with A and D are fixed at same level carries a uniformly distributed load of 2 tons /meters. EI is constant throughout. Assess the final forces by stiffness matrix method.	Understand	CO 2	BSTB01.09
8	Explain the procedure of obtaining overall stiffness matrix for stable structure by the direct stiffness method.	Understand	CO 2	BSTB01.08
9	Why is it necessary to transform the element stiffness matrix to global coordinates?	Understand	CO 2	BSTB01.09
10	Analyze the continuous beam using stiffness method. 	Analyze	CO 2	BSTB01.09
	UNIT–III			
	STIFFNESS MATRIX ASSEMBLY OF STRUCTURES AND APPLICATIONS TO SIMPLE PROBLEMS			
	Part - A (Short Answer Questions)			
1	What is meant by indeterminate structures?	Remember	CO 3	BSTB01.10
2	What are the conditions of equilibrium?	Remember	CO 3	BSTB01.11
3	Differentiate between determinate and indeterminate structures.	Understand	CO 3	BSTB01.10
4	Define degree of indeterminacy.	Remember	CO 3	BSTB01.11
5	Define internal and external indeterminacies.	Remember	CO 3	BSTB01.12
6	What are the different methods of analysis of indeterminate structures?	Understand	CO 3	BSTB01.11
7	Briefly mention the two types of matrix methods of analysis of indeterminate structures.	Understand	CO 3	BSTB01.10
8	Define a primary structure.	Remember	CO 3	BSTB01.10
9	Briefly explain the two types of DOF.	Understand	CO 3	BSTB01.12
10	Define compatibility in force method of analysis.	Understand	CO 3	BSTB01.12
	Part – B (Long Answer Questions)			
1	Develop the stiffness matrix for the beam as shown in figure.	Understand	CO 3	BSTB01.10

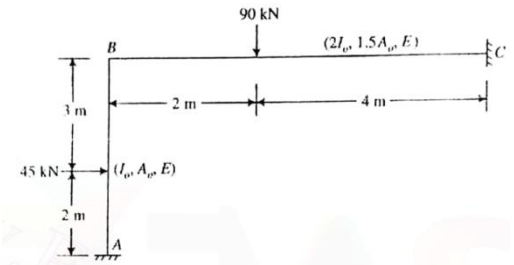
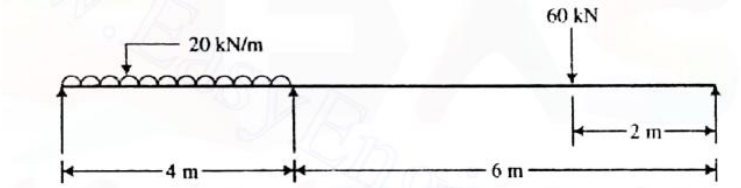
				
2	Analyze the portal frame using stiffness method (constant EI). 	Understand	CO 3	BSTB01.11
3	Analyze and draw BMD for portal frame as shown in figure using stiffness matrix method. 	Understand	CO 3	BSTB01.12
4	A two span continuous beam ABC is fixed at A and simply supported over the supports at B and C. AB = 6m BC = 4m. A uniformly distributed load of 2kN/m acts over AB and a single concentrated central load 6kN acts on BC. Analyze by stiffness matrix method.	Understand	CO 3	BSTB01.12
5	Analyze the continuous beam shown in figure .Assume EI as uniform. Use Matrix stiffness method. 	Understand	CO 3	BSTB01.12
6	Analyze the beam shown by Stiffness Method (EI is Constant) 	Understand	CO 3	BSTB01.13
7	Write a note on a) Force Method of structural analysis	Understand	CO 3	BSTB01.14

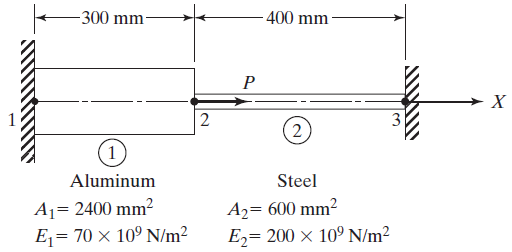
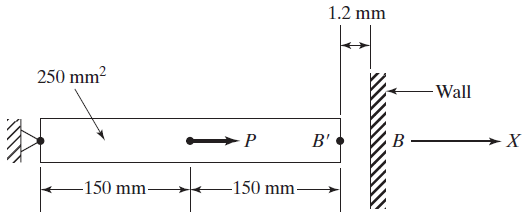
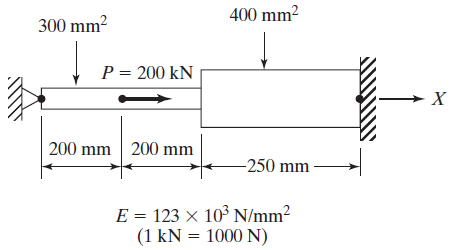
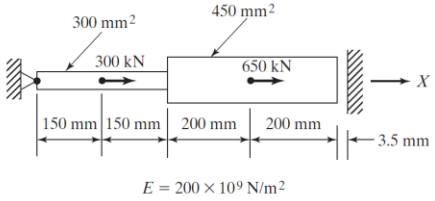
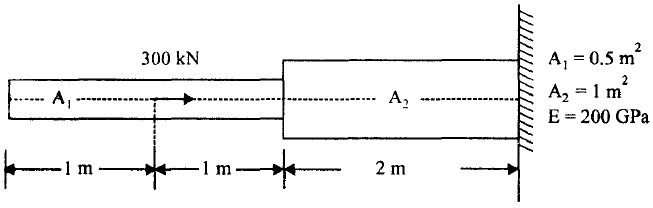
	b) Displacement Method of structural analysis			
8	Explain the steps to develop stiffness matrix for indeterminate structure.	Understand	CO 3	BSTB01.14
9	Analysis the continuous beam in figure by stiffness method. 	Understand	CO 3	BSTB01.15
10	Analyze the frame shown in figure by stiffness method. 	Understand	CO 3	BSTB01.15
	Part – C (Problem Solving and Critical Thinking)			
1	Analyze the continuous beam ABC shown in figure below by stiffness matrix method and draw the bending moment diagram. 	Analyze	CO 3	BSTB01.14
2	Examine the moment of the continuous beam shown in figure below by stiffness method. 	Analyze	CO 3	BSTB01.14
3	Analyze the continuous beam using stiffness method. 	Analyze	CO 3	BSTB01.15
4	Analyze the frame using displacement method. 	Analyze	CO 3	BSTB01.14

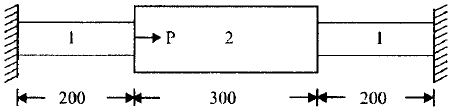
5	Analyze the continuous beam using stiffness method. 	Analyze	CO 3	BSTB01.14
06	Analyze the continuous beam using stiffness method. 	Analyze	CO 3	BSTB01.14
07	Analyze the continuous beam using stiffness method. 	Analyze	CO 3	BSTB01.15
08	Analyze the continuous beam using stiffness method. 	Analyze	CO 3	BSTB01.15
09	Analyze the frame using displacement method. 	Analyze	CO 3	BSTB01.15
10	Analyze the frame using displacement method. 	Analyze	CO 3	BSTB01.15
	UNIT–IV			
	BOUNDARY VALUE PROBLEMS (BVP)			
	Part – A (Short Answer Questions)			
1	What is meant by Finite Element Analysis?	Remember	CO 4	BSTB01.16
2	Define plane stress with a suitable example.	Remember	CO 4	BSTB01.16
3	Distinguish between essential boundary condition and natural boundary condition.	Remember	CO 4	BSTB01.17
4	What are the general constituents of finite element software?	Remember	CO 4	BSTB01.16
5	What are the merits and demerits of finite element methods?	Understand	CO 4	BSTB01.16
6	What is the principle of finite element method?	Remember	CO 4	BSTB01.16
7	List and briefly describe the general steps of the finite element method.	Understand	CO 4	BSTB01.16

8	What are the properties of shape functions?	Understand	CO 4	BSTB01.17
9	Write down the shape functions for four noded rectangular elements?	Understand	CO 4	BSTB01.17
10	Write down the expression for stiffness matrix for 1D bar element.	Understand	CO 4	BSTB01.17
	Part – B (Long Answer Questions)			
1	What are the different types of elements explain with neat sketches.	Understand	CO 4	BSTB01.16
2	What are the different coordinate systems explain with neat sketches.	Understand	CO 4	BSTB01.17
3	Determine the displacements and slopes at the nodes for the beam shown in figure. Find the moment at the midpoint of element 1. 	Understand	CO 4	BSTB01.18
4	For the stepped bar shown in the figure below, determine the nodal displacements, element stress and support reactions. Take P = 500 kN, E = 210 GPa, a1 = 200 mm2, a2 = 300 mm2 and a3 = 500 mm2. 	Understand	CO 4	BSTB01.19
5	Derive the stress-strain relationship matrix (D) for the axisymmetric triangular element.	Understand	CO 4	BSTB01.16
6	Derive the element stiffness matrix for a four noded isoparametric plan stress element.	Understand	CO 4	BSTB01.16
7	Derive the shape functions for two noded one dimensional element using Lagrange interpolation formula	Understand	CO 4	BSTB01.16
8	Explain the concept of FEM briefly and outline the procedure.	Understand	CO 4	BSTB01.17
9	Discuss the advantages and disadvantages of FEM over (i) Classical method (ii) Finite difference method.	Understand	CO 4	BSTB01.16
10	Clearly point out the situations in which FEM is preferred over other methods.		CO 4	BSTB01.18
	Part – C (Problem Solving and Critical Thinking)			
1	Analyze the continuous beam using stiffness method. 	Analyze	CO 4	BSTB01.18
2	Analyze the continuous beam using stiffness method. 	Analyze	CO 4	BSTB01.18

3	Analyze the continuous beam using stiffness method. 	Analyze	CO 4	BSTB01.18
4	Analyze the frame using stiffness method. 	Analyze	CO 4	BSTB01.18
5	Analyze the frame using stiffness method. 	Analyze	CO 4	BSTB01.19
6	Analyze the frame using stiffness method. 	Analyze	CO 4	BSTB01.19
7	Analyze the continuous beam using stiffness method. 	Analyze	CO 4	BSTB01.19
8	Develop the stiffness matrix for the continuous beam as shown in figure. 	Analyze	CO 4	BSTB01.19

9	Analyze the frame using stiffness method. 	Analyze	CO 4	BSTB01.18
10	Analyze the continuous beam using stiffness method. 	Analyze	CO 4	BSTB01.19
	UNIT -V			
	LINEAR ELEMENT			
	Part - A (Short Answer Questions)			
1	What is meant by degrees of freedom?	Understand	CO 5	BSTB01.20
2	What is Aspect ratio?	Remember	CO 5	BSTB01.20
3	What is the difference between static and dynamic analysis?	Understand	CO 5	BSTB01.20
4	Name any four FEA software.	Remember	CO 5	BSTB01.21
5	Differentiate between global and local axes.	Remember	CO 5	BSTB01.21
6	What are the types of loading acting on the structure?	Remember	CO 5	BSTB01.22
7	Write down the general finite element equation.	Understand	CO 5	BSTB01.20
8	What is discretization?	Understand	CO 5	BSTB01.20
9	What are the classifications of coordinates?	Understand	CO 5	BSTB01.22
10	What are the characteristic of shape function?	Understand	CO 5	BSTB01.22
	Part - B (Long Answer Questions)			
1	When there are several FEM packages are available is there need to study this method? Discuss.	Understand	CO 5	BSTB01.20
2	Draw a typical three dimensional element and indicate state of stress in their positive senses.	Analyze	CO 5	BSTB01.20
3	State and explain generalized Hooke's law.	Understand	CO 5	BSTB01.20
4	Give constitutive laws for three dimensional problems of (i) orthotropic materials. (ii) isotropic materials.	Analyze	CO 5	BSTB01.21
5	State and explain generalized Hooke's law.	Analyze	CO 5	BSTB01.21
6	Explain the Local coordinates, global coordinates, natural coordinates and area coordinates.	Analyze	CO 5	BSTB01.20
7	Explain the higher order elements and lower order elements.	Analyze	CO 5	BSTB01.22
8	Explain the nodes, primary nodes, secondary nodes and internal nodes.	Analyze	CO 5	BSTB01.22
9	Explain the Constant strain triangle (CST).	Analyze	CO 5	BSTB01.23
10	Explain the Linear strain triangle(LST).	Analyze	CO 5	BSTB01.23
	Part – C (Problem Solving and Critical Thinking)			
1	Consider the bar shown in Figure. An axial load P = 200kN is applied as shown. Using the penalty approach for handling boundary conditions, do the following: (a) Determine the nodal displacements. (b) Determine the stress in each material.	Analyze	CO 5	BSTB01.22

	(c) Determine the reaction forces.  			
2	In figure, a load P = 60kN is applied as shown. Determine the displacement field, stress, and support reactions in the body. Take E = 20X10^3 N/mm^2 .  	Analyze	CO 5	BSTB01.22
3	Consider the bar in figure loaded as shown. Determine the nodal displacements, element stresses, and support reactions.  	Analyze	CO 5	BSTB01.23
4	Consider the bar shown in figure. Determine the nodal displacements, element stresses and support reactions.  	Analyze	CO 5	BSTB01.23
5	Determine the nodal displacements and element stresses by finite element formulation for the following figure. Use P=300 kN; A,=0.5 m^2; A2=1 m^2; E=200 GPa  	Analyze	CO 5	BSTB01.23
6	An axial load P=200x10^3 N is applied on a bar as shown. Using the penalty approach for handling boundary conditions, determine nodal displacements, stress in each material and reaction forces.	Analyze	CO 5	BSTB01.23

	 1 - $A_1 = 2400\ mm^2$; $E_1 = 70 \times 10^9\ N/m^2$ 2 - $A_2 = 600\ mm2$; $E_2 = 200 \times 10^9\ N/m^2$			
7	Consider the truss element with the coordinates I (10,10) and 2 (50,40). If the displacement vector is q=[15 10 21 43]^T mm, then determine (i) the vector q' (ii) stress in the element and (iii) stiffness matrix if E=70 GPa and A=200 mm^2.	Analyze	CO 5	BSTB01.23

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