K.D. College of Engineering
Department of Civil Engineering
B.Tech IV Sem
Subject :- Structural Analysis

Course Objectives:

1	To make students understand the determinate and indeterminate structures, their methods of analysis and construction of influence lines.
2	To make students understand the behaviour of beams and frames using Slope Deflection Method.
3	To make students understand the concept of Method and Moment Distribution Method & Influence Line Diagram and analysis of the structural members subjected to Rolling Loads.
4	To make students understand the concept of formulation of Stiffness Matrix, Transformation Matrix, Load Matrix and its application to Beams and Plane Frames.
5	To make students understand the concept of formulation of Stiffness Matrix, Transformation Matrix, Load Matrix and its application to Plane Truss.

Course Outcomes:

CO1	Apply engineering knowledge to analyze both determinate and indeterminate structures.
CO2	Perform structural analysis of beams and frames using the Slope Deflection Method and Moment Distribution Method.
CO3	Analyze structural members by Moment Distribution Method and members subjected to rolling loads using Influence Line Diagrams (ILDs).
CO4	Analyze beams using the Direct Stiffness Method.
CO5	Formulate the Stiffness Matrix, Transformation Matrix, and Load Matrix using the Direct Stiffness Method to analyze Plane Frames.

Course Competencies:

1	**Apply knowledge of structural analysis to evaluate determinate and indeterminate structures under various loading and support conditions.**
2	**Determination of BMD & SFD of beams and frames using classical methods such as the Slope Deflection Method and Moment Distribution Method for indeterminate structures.**
3	**Analyze beams and frames using classical methods such as the Moment Distribution Method for indeterminate structures and concept of Influence Line Diagrams to determine the response of structural members subjected to moving (rolling) loads.**
4	**Utilize the Direct Stiffness Method to analyze beams, incorporating matrix-based computational techniques.**
5	**Formulate and apply the Stiffness Matrix, Transformation Matrix, and Load Matrix using the Direct Stiffness Method to analyze plane frames.**

CO-PO Articulating Matrix:

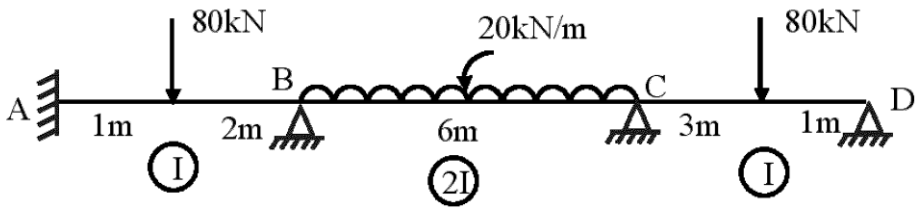
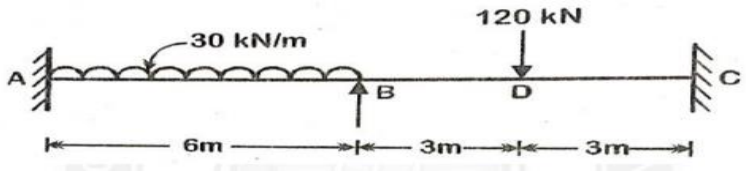
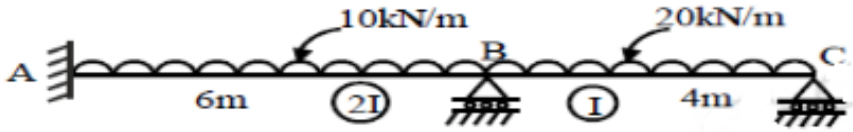
CO	Program Outcomes & Program Specific Outcomes												
	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	3	1	1	2	2			1	1		3	3
CO2	3	3	1	1	2	2			1	1		3	3
CO3	3	3	1	1	2	2			1	1		3	3
CO4	3	3	1	1	2	2			1	1		3	3
CO5	3	3	1	1	2	2			1	1		3	3

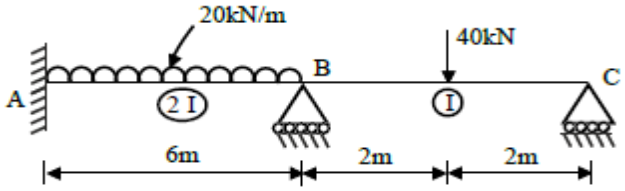
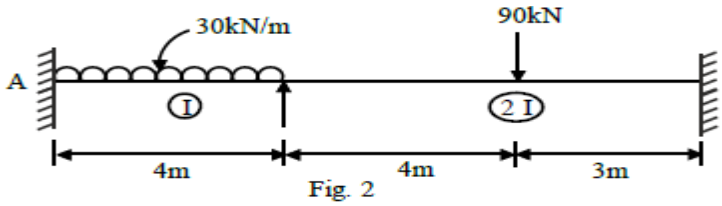
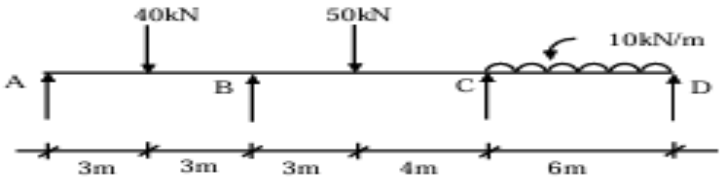
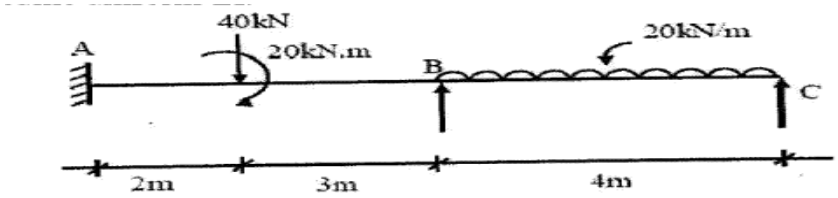
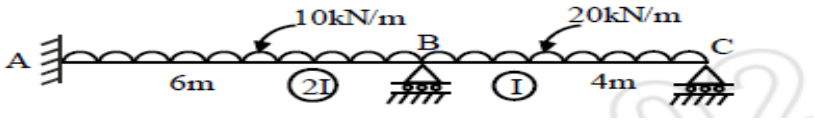
Syllabus (Theory)

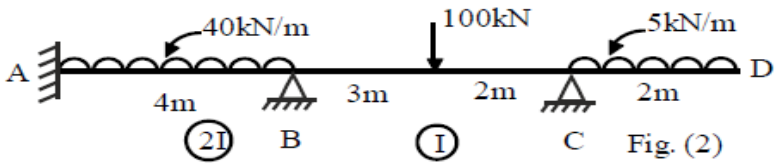
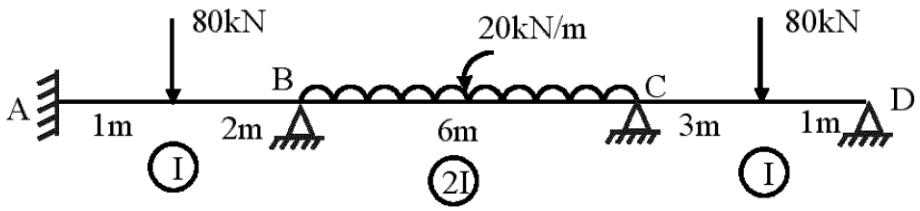
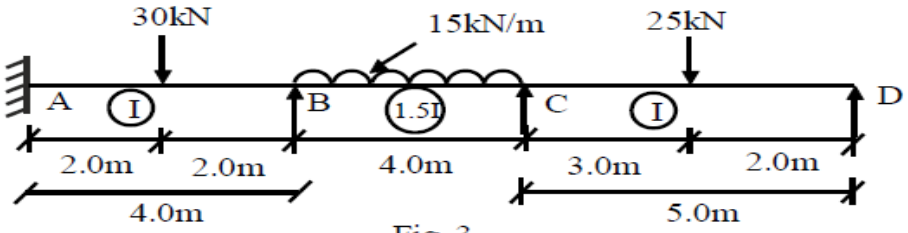
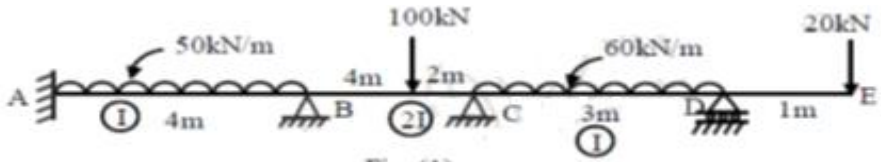
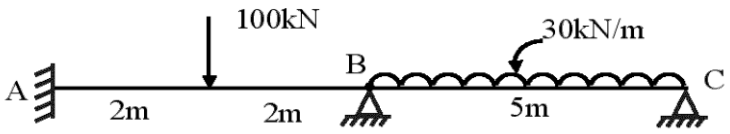
Unit	Details of Topic	Hours	CO Mapping
I	**STATICALLY INDETERMINATE STRUCTURES**		
	Introduction to Statically indeterminate Structures: Concept of Static indeterminacy.	8	**1**
	Analysis of Fixed and Continuous Beams by Three Moments Theorem, effects of Sinking of Support. Application of software for BMD & SFD		
II	**ANALYSIS OF BEAMS AND FRAMES**		
	Analysis of Continuous Beams & Portal frames by Slope Deflection Method, effects of Sinking of Support, overhang. Application of software for BMD & SFD	8	**2**
III	**ANALYSIS OF BEAMS AND FRAMES & INFLUENCE LINE DIAGRAM**		
	Analysis of Continuous Beams & Simple Portal frames (Non Sway) Using Moment Distribution Method. Rolling loads on simply supported beams with concentrated and uniformly distributed loads, maximum B.M. and S.F. Influence Line Diagrams for Reactions, Shear Forces and Bending Moments in simply supported beam, cantilevers and beams with overhangs. Application of software for BMD & SFD	8	**3**
IV	**DIRECT STIFFNESS METHOD FOR BEAMS**		

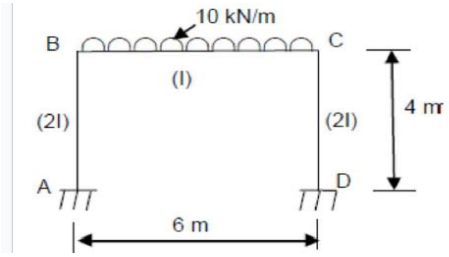
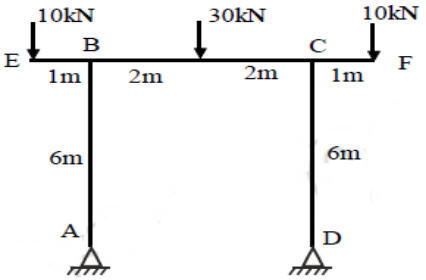
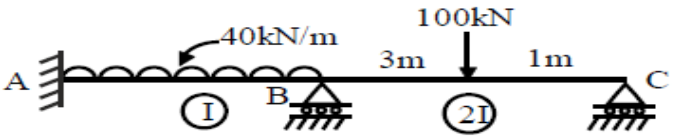
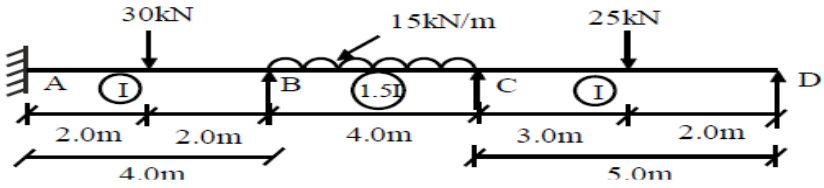
	Basic concept, Degree of Freedom, Direct Stiffness Method. Formulation of elemental/local stiffness matrix and global stiffness matrix for beam members (without axial deformation). Member load matrix due to concentrated loads, uniformly distributed loads. Transformation matrix, Assembly of global/ structural load matrix upto three elements. Solution to problems with maximum degree of freedom three. Application of software for BMD & SFD	8	**4**
V	**DIRECT STIFFNESS METHOD FOR PORTAL FRAMES**		
	Basic concept, Degree of Freedom, Direct Stiffness Method. Formulation of elemental/local stiffness matrix and global stiffness matrix for plane frame members (without axial deformation). Member load matrix due to concentrated loads, uniformly distributed loads. Transformation matrix, Assembly of global/ structural load matrix upto three elements. Solution to problems with maximum degree of freedom three Application of software for BMD & SFD	**8**	**5**

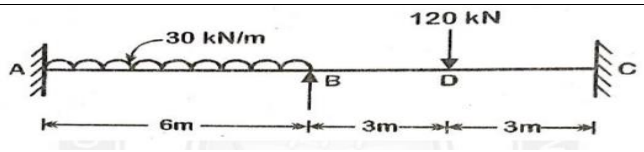
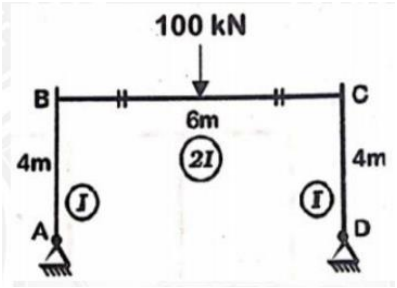
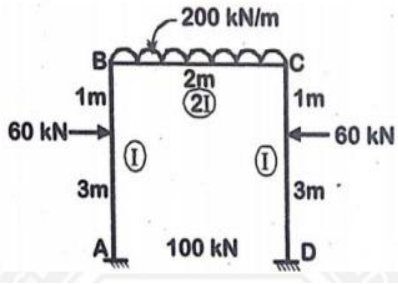
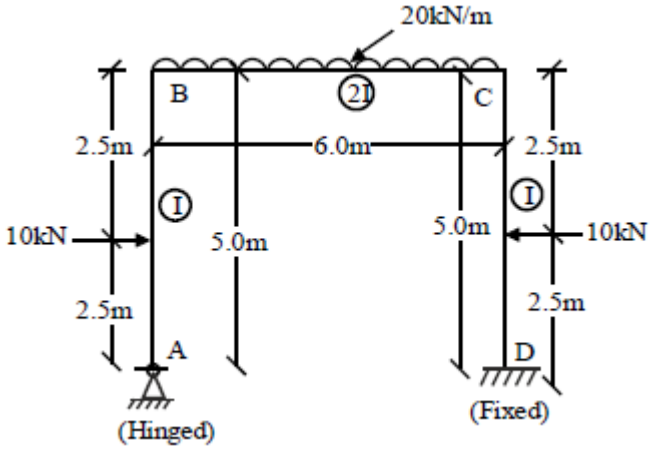
QUESTION BANK

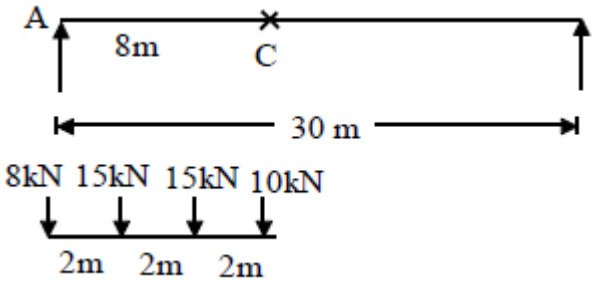
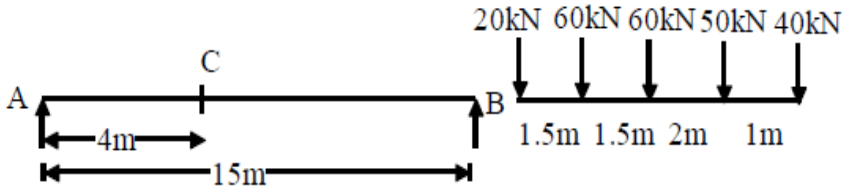
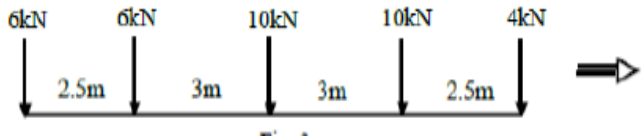
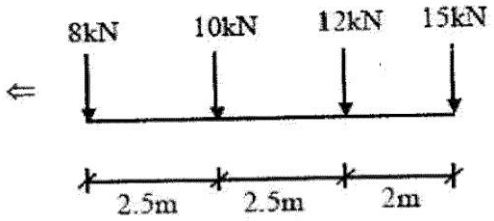
Sr. No.	Question	CO	Marks	BTL
Q1	Define statically determinate and statically indeterminate structures with suitable examples.	**01**	**02**	**01**
Q2	Explain the concept of **static indeterminacy** and **kinematic indeterminacy** of structures.	**01**	**02**	**02**
03	Explain the effect of **sinking of support** on continuous beams.	**01**	**02**	**02**
04	Find the degree of static indeterminacy of a given continuous beam. 	**01**	**02**	**01**
Q5	Analyze the continuous beam shown in fig. (1) And plot BMD using three moments Theorem. Assume constant EI. 	**01**	**08**	**04**
Q6	Analyze the continuous beam ABC shown in fig. (2) Using three moment theorem if support B sinks by 10 mm. Given, E= 200kN/mm^2 and I = 1x10^8 mm^4.  Fig. (2)	**01**	**8**	**04**

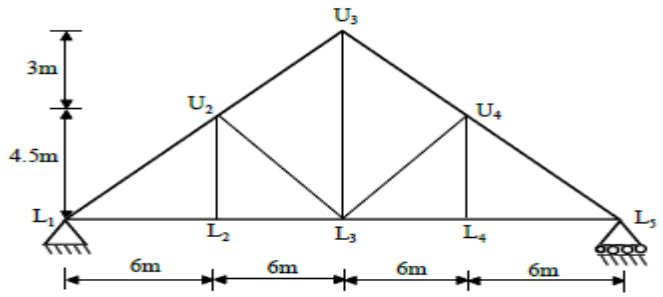
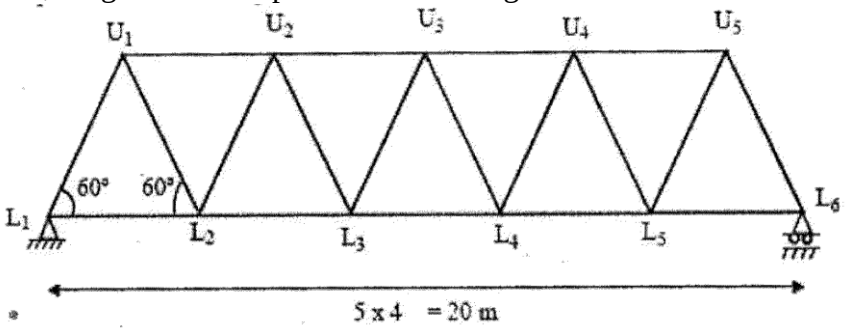
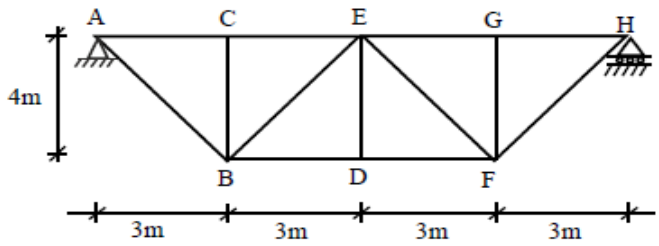
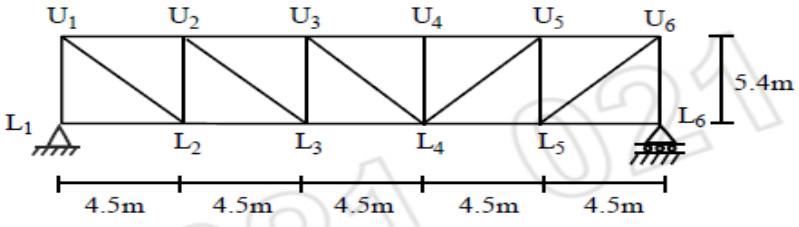
Q7	Analyse the continuous Beam by three moment theorem and draw BMD. Refer fig. 1.  Fig. 1	**01**	**8**	**04**
Q8	Determine the fixed end moment in the beam as shown in fig. (2). and plot the BMD. If support B sinks down by 20mm. Take E = $2x10^5$ N/mm^2 and I = 40 x 10^6 mm^4.  Fig. 2	**01**	**8**	**04**
Q9	A continuous beam is loaded as shown in fig. 1 If support 'B' Sinks by 10mm, illustrate the moments and reaction at support and Draw BMD by three moment theorem. Take E = $2x10^8$ kN/m^2 & I = $8.5x10^{-5}$ m^4  Fig. 1	**01**	**8**	**04**
Q10	Analyse the continuous beam as shown in figure by using three moment equation and draw BMD. Assume uniform EI.  	**01**	**8**	**04**
Q11	Analyse the continuous beam ABC shown in fig. if support B sinks by 10 mm. Given E = 200kN/mm^2 and I=$1x10^8$ mm^4.  	**01**	**8**	**04**
Q8	Analyse the beam ABCD as shown in fig. if support B sink by 10 mm. Given and E = 200kN/mm^2 , I= $1x10^8$ mm^4.	**01**	**8**	**04**

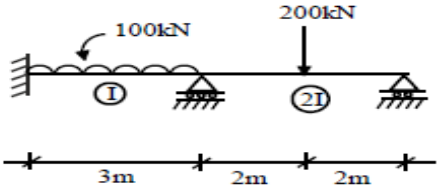
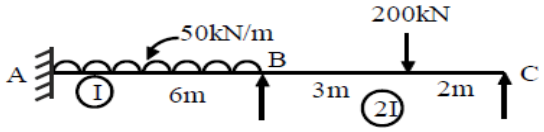
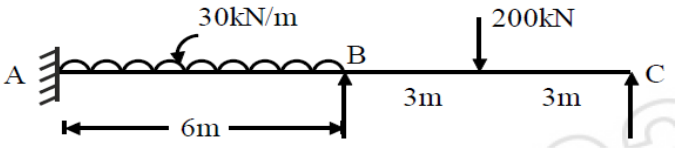
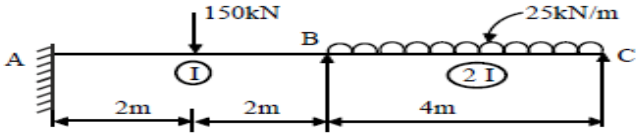
	 Fig. (2)			
	Unit II			
Q1	List the assumptions and applications of the **Slope Deflection Method**.	**02**	**02**	**01**
Q2	What is the slope deflection equations for a prismatic member.	**02**	**02**	**01**
Q3	Derive the slope deflection equations for a prismatic member.	**02**	**04**	**02**
Q4	Analyse the continuous beam shown in figure using SDM and draw SFD and BMD. 	**02**	**8**	**04**
Q5	Analyse the continuous beam by slope deflection method shown in fig. (3) and draw BMD.  Fig. 3	**02**	**8**	**04**
Q6	Analyse the continuous beam shown in figure using SDM and draw SFD and BMD.  Fig. (1)	**02**	**8**	**04**
Q7	Analyse the continuous beam shown in figure and draw SFD and BMD. Assume constant EI. Support B sinks by 8 mm. Given E = 200kN/mm2 and I=2x108 mm4. 	**02**	**8**	**04**

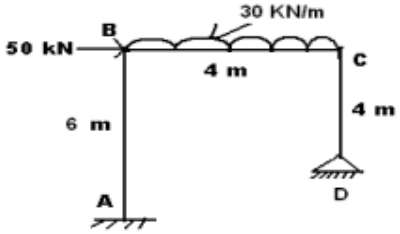
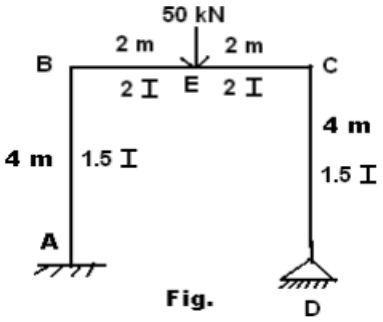
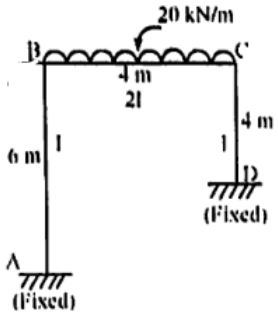
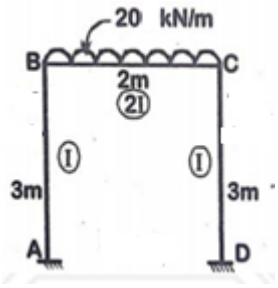
Q8	Analyse the portal frame shown in fig. using slope deflection method and draw BMD. 	**02**	**8**	**04**
Q9	Analyse the portal frame shown in fig. (4) using slope deflection method and draw BMD. 	**02**	**8**	**04**
	UNIT- III			
Q1	Define stiffness factor, distribution factor, and carry-over factor.	**03**	**04**	**01**
Q2	What is the formula for relative stiffness when, i) Farther end is hinged ii) Farther end is fixed	**03**	**04**	**01**
Q3	Analyse the continuous beam ABC shown in fig. and plot BMD using Moment distribution method. 	**03**	**8**	**04**
Q4	Analyse the continuous beam shown in fig. by using Moment distribution method. Draw BMD. 	**03**	**8**	**04**
Q5	Analyse the continuous beam shown in fig. by using Moment distribution method. Draw BMD.	**03**	**8**	**04**

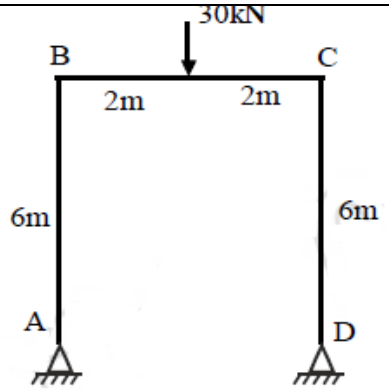
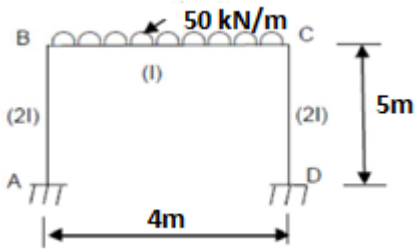
				
Q6	Analyse the frame shown in fig. by using Moment distribution method. Draw BMD. 	**03**	**8**	**04**
Q7	Analyse the frame shown in fig. by using Moment distribution method. Draw BMD. 	**03**	**8**	**04**
Q8	Analyse the frame shown in fig. by using Moment distribution method. Draw BMD. 	**03**	**8**	**04**
Q9	Define Influence Line Diagram and explain its importance.	**03**	**02**	**01**
Q10	Draw ILD for reactions of a simply supported beam.	**03**	**02**	**01**
Q11	Draw ILD for shear force at a given section of a simply supported beam.	**03**	**02**	**01**
Q8	Draw ILD for bending moment at a given section of a simply supported beam.	**03**	**02**	**01**
Q13	Four point loads 8, 15, 15 and 10 kN have centre to centre spacing of 2m between consecutive loads and they traverse a girder of 30 m span from left to right with 10 kN load leading. Calculate the maximum bending moment at 8 m from left support as shown in fig.	**03**	**8**	**04**

				
Q14	The system of concentrated load as shown in fig. rolls from left to right on the girder of span 15 m, 40 kN load leading. For a section 4 m from left support determine Maximum shear force. 	**03**	**8**	**04**
Q15	Rolling load as shown in fig. is moving left to right on 40m girder. Find maximum bending moment, Max. SF at 20 m from left support. Also calculate absolute max. BM and SF anywhere. 	**03**	**8**	**04**
Q16	Four loads as shown in fig. are travelling over a girder of 25 m span from right to left with 8 kN load leading. Calculate the maximum bending moment and shear force at 7 m from left support. Also calculate the absolute maximum bending moment. 	**03**	**8**	**04**
Q17	Draw the Influence lines for the forces in the members U2 U3, L2 L3 of the truss shown in fig. If a live load of 6.5 kN/m longer than the span, traverses the girder. Find maximum values of forces in the members mentioned above.	**03**	**8**	**04**

				
Q18	Draw the influence line diagrams for forces in the members U2U3, L3U3, L3L4and U3L4 of truss shown in fig. if uniformly distributed load of 50 kN/m, longer than the span traverses along the bottom chord members. 	**03**	**8**	**04**
Q19	For the deck type of truss as shown in fig. Draw ILD for i) Force in member BC ii) Force in member BD iii) Force in member BE 	**03**	**8**	**04**
Q20	Draw the influence line diagrams for forces in members U2U3, U2L3 and L2L3 of truss shown in fig. when uniformly distributed load 60 kN/m longer than the span moves from left to right on top chord. 	**03**	**8**	**04**

	UNIT – IV			
1	Derive member stiffness matrix for a prismatic plane beam element	**05&06**	**04**	**02**
2	Derive rotation transformation matrix for plane beam element	**05&06**	**04**	**02**
3	What is the significance of the transformation matrix in the Direct Stiffness Method?	**05&06**	**02**	**02**
4	What is the size of the transformation matrix for a plane beam element?	**05&06**	**02**	**02**
5	What is the order of the local stiffness matrix for a plane beam element?	**05&06**	**02**	**02**
Q6	Analyse the beam shown in fig by stiffness method and draw BMD. 	**05**	**8**	**04**
Q7	Analyse the beam by stiffness method and draw BMD. Refer fig. 	**05**	**8**	**04**
Q8	Analyse the beam by stiffness method and draw BMD. Refer fig. No. 	**05**	**8**	**04**
Q9	Analyse the beam by stiffness method and draw BMD. Refer fig. 	**05**	**8**	**04**

	UNIT- V			
Q1	Analyse the portal frame ABCD shown in figure using stiffness method  Fig.	**06**	**8**	**04**
Q2	Analyse the portal frame ABCD shown in figure by stiffness method and sketch the bending moment diagram.  Fig.	**06**	**8**	**04**
Q.3	Analyse the portal frame ABCD shown in figure by stiffness method and sketch the bending moment diagram. 	**06**	**8**	**04**
Q.4	Analyse the portal frame ABCD shown in figure by stiffness method and sketch the bending moment diagram. 	**06**	**8**	**04**
Q.5	Analyse the portal frame ABCD shown in figure by stiffness method and sketch the bending moment diagram.	**06**	**8**	**04**

				
Q.6	Analyse the portal frame ABCD shown in figure by stiffness method and sketch the bending moment diagram 	**06**	**8**	**04**

Subject Teacher

Dr. Vinayak D. Vaidya