Techno India NJR Institute of Technology

Course File

Structural Analysis-II (6CE4- 02)

Basant kumar Bansal

(Assistant Professor)

Department of CE

6CE4-02: STRUCTURAL ANALYSIS-II

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	CONTENTS	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Unit load method & their applications: deflection of determinate beams and frames, analysis of determinate and redundant frames up to two degree of redundancy, lack of fit in redundant frames. Introduction to Energy Methods: Strain energy for gradually applied, suddenly applied and impact loads, Strain energy due to axial loads, bending, shear and torsion;. Castiglione's theorems & their applications in analysis of determinate and redundant frames up to two degree of redundancy and trussed beams; Stresses due to temperature & lack of fit in redundant frames; deflection of determinate beams, frames using energy methods	12
3	**Influence line diagram & Rolling load:** ILD for beams & frames, Muller-Breslau principle and its application for drawing ILD, Rolling load, maximum stress resultants in a member/section, absolute maximum stress resultant in a structure.	10
4	**Arches:** analysis of three hinged two hinged and fixed type parabolic arches with supports at the same level and at different levels.	7
5	**Unsymmetrical bending:** Definition, location of NA, computation of stresses and deflection, shear centre and its location,	6
6	**Approximate methods for lateral loads:** Analysis of multistory frames by portal method, cantilever method & factor method. Analysis of determinate space trusses by tension coefficient method.	6
	TOTAL	42

Course Overview:

This course is designed to review the fundamentals and practices of structural engineering within the Civil Engineering curriculum. Students will explore the concept of global structural stability, theory of structural analysis, and methods in structural analysis. Students who successfully complete this course will be able to:

Course Objective:

1. Understand analysis of statically indeterminate structures and its application to one dimensional member
2. Understand different methods and their advantages to analyze the indeterminate structures
3. Understand matrix method of analysis and be able to develop computer programs to analyze two-dimensional plane structures
4. Understand plastic analysis of structures and be able to analyze collapse load for beams and frames5. Ability to model and analyze structural systems (bridge and building) with the aid of SAP 2000 and ETABS software.

Course Outcomes:

CO. NO.	Cognitive Level	Course Outcome
1	Application	The student will be able to state the advanced methods of analysis of structures like flexibility and stiffness method, kanis method, Moment distribution method, Slope and deflection method.
2	Analysis	Learner will be able to test and analysis of beams by using an advanced method of analysis.
3	Analysis	Students will be able to define the procedure for doing analysis of portal frame.
4	Application	Learner can explain the procedure to calculate stresses, shear center and deflection of unsymmetrical section.
5	Analysis	Learner can explain the procedure for analysis of multistory frames by portal, cantilever and factor methods

Prerequisites:

1. Student will be able to study advanced methods of analysis of structures
2. Students are able to do the analysis of beams by using an advanced method of analysis
3. Students are able to do analysis of portal frame, cantilever frame.
4. Students will be able to determine response of structures by classical, iterative and matrix methods.
5. Students will be able to understand analysis of indeterminate structures

Course Outcome Mapping with Program Outcome:

STRUCTURAL ANALYSIS-II															
Course Outcome	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO362.1	2	2	2	2	0	1	1	0	0	0	0	1	1	1	1
CO362.2	2	2	2	2	1	1	0	0	0	1	0	0	1	1	1
CO362.3	2	2	2	1	2	2	2	2	1	1	2	1	1	1	1
CO362.4	3	3	3	3	2	2	1	1	2	1	1	1	2	2	2
CO362.5	3	2	2	2	1	1	1	1	2	1	1	1	2	2	2
CO362 (AVG)	2.4	2.2	2.2	2	1.2	1.4	1	0.8	1	0.8	0.8	0.8	1.4	1.4	1.4

Course Coverage Module Wise:

Lecture No.	Unit	Topic
1	**1**	**INTRODUCTION:** Objective, scope and outcome of the course
2	**2**	Student should be able to understand Deflection of determinate beams and frames
3	2	Student should be able to understand Deflection of determinate beams and frames
4	2	Student should be able to understand Deflection of determinate beams and frames
5	2	Student should be able to analysis of determinate and redundant frames up to 2 degree of redundancy
6	2	Student should be able to analysis of determinate and redundant frames up to 2 degree of redundancy, lack offit in redundant frames
7	2	Student should be able to understand strain energy for gradually applied, suddenly applied and impact loads
8	2	Student should be able to understand Strain energy due to axial loads, bending, shear and torsion
9	2	Student should be able to understand Castiglione's theorems & their applications in analysis of determinate & redundant frames up to 2 degree of redundancy and trussed beams
10	2	Student should be able to solve problem based on (Contd.) Castiglione's theorems & their applications
11	2	Student should be able to solve problem based on (Contd.) Castiglione's theorems & their applications

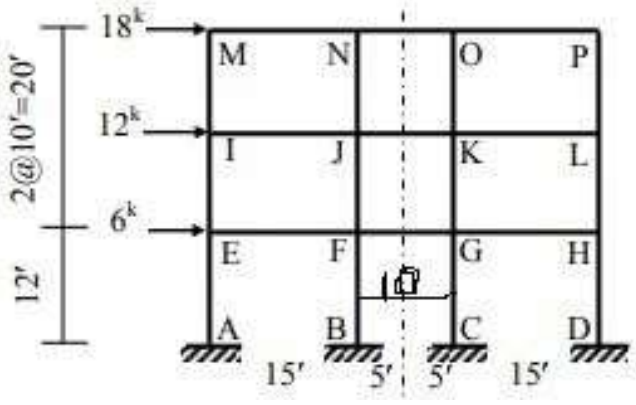
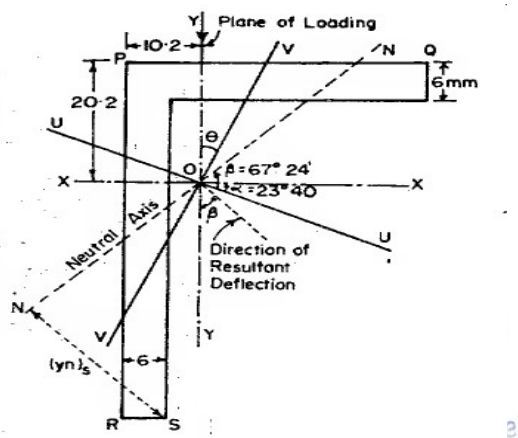
12	2	Student should be able to solve problem based on (Contd.) Castiglione's theorems & their applications
13	2	Student should be able to understand Stresses due to temperature & lack of fit in redundant frames.
14	2	Student should be able to understand Stresses due to temperature & lack of fit in redundant frames
15	2	Student should be able to understand deflection of determinate beams, frames using energy methods
16	2	Student should be able to understand deflection of determinate beams, frames using energy methods
17	3	Student should be able to understand Influence line diagram & Rolling load: ILD for beams & frames
18	3	Student should be able to solve NUMERICAL based ON ILD FOR BEAMS.
19	3	Student should be able to solve NUMERICAL based ON ILD FOR BEAMS
20	3	Student should be able to solve NUMERICAL based ON ILD FOR BEAMS
21	3	Student should be able to solve NUMERICAL based ON ILD FOR BEAMS
22	3	Student should be able to solve NUMERICAL based ON ILD FOR BEAMS
23	3	Student should be able to solve NUMERICAL based ON ILD FOR BEAMS
24	3	Student should be able to understand Muller-Breslau principle and its application for drawing ILD
25	3	Student should be able to solve problem based on (Contd.) Muller-Breslau principle
26	3	Student should be able to solve problem based on (Contd.) Muller-Breslau principle
27	3	Student should be able to solve problem based on (Contd.) Muller-Breslau principle
28	3	Student should be able to understand Maximum stress resultants in a member
29	3	Student should be able to understand Maximum stress resultants in a member
30	4	Student should be able to Analysis of three hinged parabolic Arches with supports at the same level and at different levels
31	4	Student should be able to solve problem (Contd.) Analysis of three hinged parabolic
32	4	Student should be able to solve problem (Contd.) Analysis of three hinged parabolic
33	4	Student should be able to Analysis of two hinged parabolic Arches with supports at the same level and at different levels
34	4	Student should be able to Analysis of two hinged parabolic
35	4	Student should be able to Analysis of two hinged parabolic.
36	4	Student should be able to Analysis of two hinged parabolic

37	4	Student should be able to Analysis of fixed type parabolic Arches with supports at the same level and at different levels
38	5	Student should be able to understand Definition, location of NA
39	5	Student should be able to understand Computation of stresses and deflection
40	5	Student should be able to understand Computation of stresses and deflection
41	5	Student should be able to understand Shear center and its location.
42	5	Student should be able to understand Shear center and its location.
43	5	Student should be able to understand Shear center and its location.
44	6	Student should be able to Analysis of multistory frames by portal method
45	6	Student should be able to solve problem based on Portal Method
46	6	Student should be able to solve problem based on Portal Method
47	6	(Student should be able to solve problem based on Portal Method
48	6	Student should be able to solve problem based on Portal Method
49	6	Student should be able to solve problem based on Cantilever method & factor method
50	6	Student should be able to solve problem based on Cantilever method & factor method
51	6	Student should be able to solve problem based on Cantilever method & factor method
52	6	Student should be able to solve problem based on Cantilever method & factor method
53	6	Student should be able to Analysis of determinate space trusses by tension coefficient method
54	6	Student should be able to solve problem based on (Contd.) tension coefficient method

TEXT/REFERENCE BOOKS

1. Strength of Materials & Mechanics of Structures: Vol. I by Dr. B.C.Punmia Laxmi Publications (p) Ltd.
2. Theory of Structure by Jangid & Negi, Tata Mc Graw Hill.
3. Structural Analysis by Hibbler R.C., Pearsons.

Course Level Problems (Test Items):

CO.NO.	Problem description
1	A. Define unsymmetrical bending B. Explain principal centroidal axes of the cross-section C. What are the differences between simple bending and unsymmetrical bending theories
2	A. Establish relation between principal centroidal axes and any pair of centroidal rectangular axes if angle between one principal and onr rectangular axis is α B. What are assumptions in portal method? C. What are assumptions in cantilever method?
3	Analyse the building frame, subjected to horizontal forces, as shown in Fig. 1. Use Portal Method / Cantilever Method. 
4	A 60 mm x 40 mm x6 mm unequal angle is placed with the longer leg vertical and is used as a beam it is subjected to a bending moment of 12 kN- cm acting in the vertical plane through the centroid of the section determine the maximum bending stress induced in the section. 

Dr. Pankaj Kumar
(Principal)

Assessment Methodology:

1. Practical exam in lab where they have to analyze problem statement. (Once in a week)
2. Assignments one from each unit.
3. Midterm subjective paper based on topics as mentioned in the modules. (Twice during the semester)
4. Final paper at the end of the semester subjective

Teaching and Learning resources unit-wise:

INFLUENCE LINE DIAGRAM

Video Tutorials: https://youtu.be/RyNsxkdEv00

Theory concepts: https://eng.libretexts.org/Bookshelves/Civil_Engineering/Book%3A_Structural_Analysis_(Udoeyo)/01%3A_Chapters/1.09%3A_Influence_Lines_for_Statically_Determinate_Structures

Sample Quiz: https://testbook.com/objective-questions/mcq-on-influence-line-diagram-and-rolling-loads--5eea6a0839140f30f369d824

Unsymmetrical Bending

Video Tutorials: https://youtu.be/BRYnX6UFiZY

Theory concepts: https://www.ques10.com/p/25873/explain-unsymmetrical-bending/#:~:text=When%20the%20plane%20of%20bending,as%20complex%20or%20biaxial%20bending.&text=If%20it%20does%20not%2C%20the,combined%20bending%20and%20torsion%20loading.

Sample ppt: https://engineeringinterviewquestions.com/mcqs-on-bending-stress-in-unsymmetrical-sections-and-answers/

Analysis of Arches

Video Tutorials: https://youtu.be/2RZKK4LhUas

Theory concepts: https://structville.com/2017/06/manual-structural-analysis-of-three-hinged-arch-structures.html#:~:text=The%20structural%20analysis%20and%20design,to%20resist%20the%20applied%20load.

Sample Quiz: https://testbook.com/objective-questions/mcq-on-arches--5eea6a0839140f30f369d82a

B. Cable and Suspension

Video Tutorials: https://youtu.be/jr51Ekq6bbI

Theory concepts: https://www.brainkart.com/article/Suspension-Cable-Structural-Analysis_4594/

Sample Quiz: https://testbook.com/objective-questions/mcq-on-cables-and-frames--5eea6a0839140f30f369d820

A. Portal Method

Video Tutorials: https://youtu.be/_DnVJhy7Ntk

Theory concepts: https://learnaboutstructures.com/Portal-Method

Sample Quiz: https://www.sanfoundry.com/structural-analysis-questions-answers-quiz/

B. Cantilever Method

Video Tutorials: https://youtu.be/gpKb3sc3_Dw

Theory concepts: https://learnaboutstructures.com/Cantilever-Method

Sample Quiz: https://engineeringinterviewquestions.com/mcqs-on-lateral-loads-on-building-frames-portal-and-cantilever-method-and-answers/

For Techno India NJR Institute of Technology
पंकज पोरवाल
Dr. Pankaj Kumar Porwal
(Principal)

Previous Year Question Papers:

5E5061

Roll No. 15CETC6049 [Total No. of Pages : 4]

5E5061

B.Tech. V Semester (Main & Back) Examination, Nov./ Dec. - 2017

Civil Engineering

5CE1A Theory of Structures - I

Time : 3 Hours **Maximum Marks : 80**

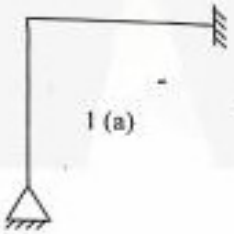
Min. Passing Marks : 26

Instructions to Candidates:

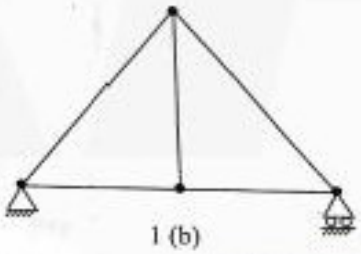
*Attempt any **five questions**, selecting **one question** from **each unit**. All Questions carry **equal** marks. (Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly). Units of quantities used/calculated must be stated clearly.*

Unit - I

1. a) Define kinematic, indeterminacy. Calculate kinematic indeterminacy for the following structures. **(6)**



1 (a)



1 (b)

b) Write and prove Maxwell Betti's generalized reciprocal theorem. **(4)**

c) In a cantilever Beam AB, of span l, fixed at A and carrying a point load P at the free end B, the deflection 'y' of a section X, distance x from A is given by $y = \frac{px^2(3l-x)}{6EI}$. If the cantilever is now loaded with a concentrated load W at X and propped at B to the same level as A, show by the reciprocal theorem, that the reaction $R_B = \frac{Wx^2(3l-x)}{2l^3}$ E is modulus of elasticity and I is moment of inertia of the beam. **(6)**

OR

1. Analyze the rigid frame shown in fig. 2 using slope-deflection method. Draw the BMD. **(16)**

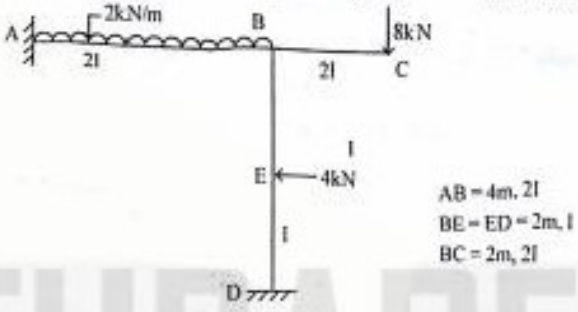


Fig. 2

Unit - II

2. A portal frame ABCD as shown in fig. 3 is hinged at A and fixed at end D. Analyze the frame using moment distribution method and draw the BMD and deflected shape. **(16)**

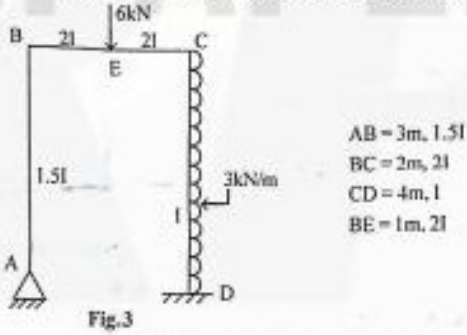
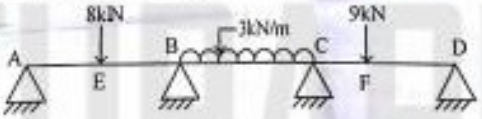


Fig.3

OR

2. A horizontal beam ABCD is supported on hinges at all the supports. The beam is loaded as shown in Fig. 4. Take moment of inertia as $2.4 \times 10^6 mm^4$ and $E = 2 \times 10^5$ N/mm^2. Solve the beam using moment distribution method if the support B sinks by 30mm and C sinks by 20mm down respectively from the original some level. Draw BMD and deflected slope of beam. **(16)**



AE = EB = 1.5m
BC = 3m
CF = 1m
FD = 2m

Fig. 4