

Techno India NJR Institute of Technology



Course File

Structural Analysis-II (6CE4- 02)

Session 2022-23

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Department of CE



RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

3rd Year - VI Semester: B.Tech. (Civil Engineering)

6CE4-02: STRUCTURAL ANALYSIS-II

Credit: 3
3L+0T+0P

Max. Marks: 150(IA:30, ETE:120)
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

Office of Dean Academic Affairs
Rajasthan Technical University, Kota

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 frames
5. 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 structure.

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 upto 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	D. Establish relation between principal centroidal axes and any pair of centroidal rectangular axes if angle between one principal and one rectangular axis is α E. What are assumptions in portal method? F. 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. <div style="text-align: center;"> </div>
4	A 60 mm x 40 mm x 6 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.

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](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/>

Previous Year Question Papers:

Roll No. 156070049[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 HoursMaximum 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)

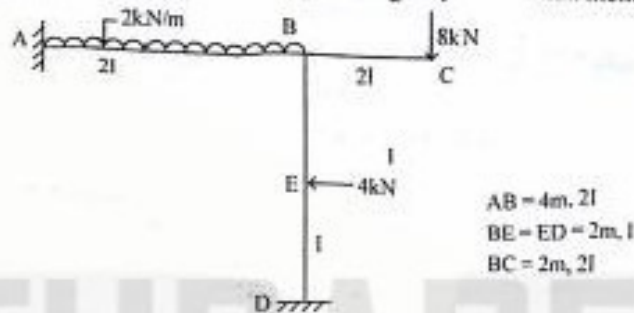
c) In a cantilever Beam AB, of span l , fixed at A and carrying a point load P at the free end B, the deflection 'y' of a section X, distance x from A is given by $y = \frac{px^2(3l-x)}{6EI}$. If the cantilever is now loaded with a concentrated load W at X and propped at B to the same level as A, show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

SE5061 /2017(1)[Contd....]

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पंकज पोरवाल
Dr. Pankaj Kumar Porwal
(Principal)

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

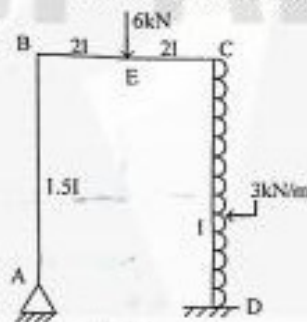


AB = 4m, 2I
BE = ED = 2m, I
BC = 2m, 2I

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)

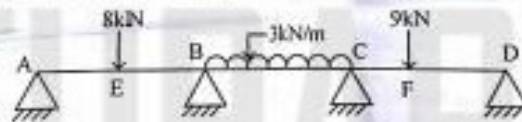


AB = 3m, 1.5I
BC = 2m, 2I
CD = 4m, I
BE = 1m, 2I

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 $2.4 \times 10^6 \text{ mm}^4$ and $E = 2 \times 10^7 \text{ N/mm}^2$. Solve the beam using moment distribution method if the support B sinks by 30mm and C sinks by 20mm down respectively from the original same level. Draw BMD and deflected slope of beam. (16)



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

Fig. 4

(2)

SE5061

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पंकज पौरवाल

Dr. Pankaj Kumar Perwal
(Principal)

MULTIPLE CHOICE QUESTIONS

1. Which of the following structural loads are not applied commonly to a building?
 - a) Environmental load
 - b) Live load
 - c) Dead load
 - d) Rain load
2. In the case of a structural member supporting more than one floor with load exceeding 100psf., what is the maximum permitted reduction %?
 - a) 20
 - b) 25
 - c) 15
 - d) 10
3. Which of the following is statically determinate structure?
 - a) Two hinged arch
 - b) Fixed beam
 - c) Double overhanging
 - d) Continuous beam
4. In the equation $U=0.9D + 1.6W + 1.6H$, what is the load factor for H if the structural action of H counteracts that due to W or E?
 - a) 0.005
 - b) 0
 - c) 0.1
 - d) 0.05
5. What will be V_{max} in the above question if the hospital is made up of structural steel frames?
 - a) .04813gw
 - b) .01813gw

- c) .02813gw
- d) .03813gw

6. If we use link support in a structural system, then how many unknowns would we have?
- a) 1
 - b) 2
 - c) 0
 - d) 4

7. Which of the following material is not used in making trusses?
- a) Metal bars
 - b) Concrete
 - c) Wooden struts
 - d) Channel

8. Calculate the force in member BC.
- a) 0KN
 - b) $2\sqrt{2}$ KN (TENSILE)
 - c) 1KN (TENSILE)
 - d) 1KN (COMPRESSIVE)

9. Why is base plate provided in short roof trusses?
- a) For rigidity
 - b) As provision for temperature related expansion/contraction
 - c) To transmit load effectively
 - d) For stability

10. Calculate the kinematic indeterminacy of the following pin jointed plane frame.
- a) 15
 - b) 12
 - c) 13
 - d) 14



ASSIGNMENT NO.1

1. What is an arch? Explain.
2. What are the methods used for analysis of fixed arches?
3. Distinguish between two hinged and three hinged arches?
4. Give the equation for a parabolic arch whose springing is at different levels?
5. State Eddy's theorem as applicable to arches? 6. Explain the effect of temperature on the horizontal thrust of a two hinged arch subjected to a system of vertical loads?
7. Indicate the positions of a moving point load for maximum negative and positive Bending moments in a three hinged arch.
8. Write down the expressions for radial shear and normal thrust in a three hinged parabolic arch?



ASSIGNMENT NO.2

1. Define radial shear and normal thrust.
2. Mention the examples where arch action is usually encountered?
3. What is a linear arch?
4. What is the degree of static indeterminacy of a three hinged parabolic arch?
5. Under what conditions will the bending moment in an arch be zero throughout?
6. Distinguish between two hinged and three hinged arches?
7. In a parabolic arch with two hinges how will you calculate the slope of the arch at any point?
8. How will you calculate the horizontal thrust in a two hinged parabolic arch if there is a rise in temperature?
9. What are the types of arches according to their shapes?
10. What are the types of arches according to their support conditions?
11. Draw the influence line for radial shear at a section of a three hinged arch?
12. Write the formula to calculate the change in rise in three hinged arch if there is a rise in temperature.

