INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

CIVIL ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**STRUCTURAL ANALYSIS – II**			
Course Code	**A60131**			
Regulation	**R15 – JNTUH**			
Course Structure	Lectures	Tutorials	Practicals	Credits
	4	-	-	4
Course Coordinator	Mrs. S Bhagyalaxmi, Asst Professor, Department of CE.			
Team of Instructors	Dr. M Venu Professor Mrs. S Bhagya Laxmi, Assistant Professor			

I. COURSE OVERVIEW:

Civil engineers are required to plan, analyse and design structures like buildings, arches, dams and bridges. This course focuses on advanced level concepts on structural analysis of beams, frames, trusses and arches, which form the skeletal super-structure for buildings and bridges. Structural analysis involves computation of the shear forces and bending moments in various components of a structure. In this course, various methods for analysis of continuous beams and simple / large frames are introduced, namely Slope Deflection method, Moment Distribution method, Kani's method, Approximate methods (such as Portal method, Cantilever method, Substitute frame methods). A civil engineer could choose one of the methods as suitable for analysis of small structures by hand-calculations. For computer-aided analysis of large structures and frames, the Matrix Methods of analysis are used, the concepts of which are also introduced. Through this course a civil engineering student can learn all the important methods using in analysis of structures, the results of which are then used for safe design of buildings and bridges.

II. PREREQUISITE(S):

Level	Credits	Periods/ Week	Prerequisites
UG	4	4	Engineering Mechanics, Strength of Materials, Structural Analysis-I

III. MARKS DISTRIBUTION:

Sessional Marks	University End Exam marks	Total marks
Midterm Test There shall be two midterm examinations. Each midterm examination consists of essay paper, objective paper and assignment. The essay paper is for 10 marks of 60 minutes duration and shall contain 4 questions. The student has to answer 2 questions, each carrying 5 marks. The objective paper is for 10 marks of20minutes duration. It consists of 10 multiple choice and 10 fill-in-the blank questions, the student has to answer all the questions and each carries half mark. First midterm examination shall be conducted for the first two and half units of syllabus and second midterm examination shall be conducted for the remaining	75	100

Sessional Marks	University End Exam marks	Total marks
portion. Five marks are earmarked for assignments. There shall be two assignments in every theory course. Assignments are usually issued at the time of commencement of the semester. These are of problem solving in nature with critical thinking. Marks shall be awarded considering the average of two midterm tests in each course.		

IV. EVALUATION SCHEME:

S. No	Component	Duration	Marks
1.	I Mid Examination	80 minutes	20
2.	I Assignment	-	5
3.	II Mid Examination	80 minutes	20
4.	II Assignment	-	5
5.	External Examination	3 hours	75

V. COURSE OBJECTIVES:

The course will impart to the students the knowledge and skills of:

I. Slope deflection, moment distribution and Kani's methods of analysis of indeterminate frames
II. Analysis of two-hinged arches using energy methods
III. Approximate methods of structural analysis for 2D frame structures for horizontal and vertical loads such as cantilever, portal and substitute frame methods
IV. Matrix methods of structural analysis with stiffness and flexibility matrices to analyze continuous beams, portal frames and trusses
V. Draw the influence line diagrams for indeterminate beams using Muller-Breslau principle
VI. Analysis of indeterminate trusses using energy methods

VI. COURSE OUTCOMES:

By the end of the course the student is expected to be able to:

1. Contrast between the concept of force and displacement methods of analysis of indeterminate structures
2. Analyze the methods of moment distribution to carry out structural analysis of 2D portal frames with various loads and boundary conditions.
3. Understand working methodology of Kani's method and compare that with moment distribution method
4. Apply the methods of slope deflection to carry out structural analysis of 2D portal frames with various loads and boundary conditions.
5. Analyse the parabolic arches for the shear forces and bending moments.
6. Execute secondary stresses in two hinged arches due to temperature and elastic shortening of rib.
7. Construct the shear forces and bending moments of 2D portal frames with various loads and boundary conditions.
8. Evaluate the shear forces and bending moments in two-hinged arches using energy methods.
9. Differentiate Static and kinematic Indeterminacy.
10. Analyze 2D frame structures for horizontal and vertical loads by approximate methodssuch as cantilever and substitute frame methods

11. Analyze indeterminate structures such as continuous beams, portal frames and trusses using stiffness and flexibility matrix methods.
12. Analyze statically indeterminate structures using stiffness method.
13. Evaluate statically indeterminate structures using flexibility method.
14. Execute 2D frame structure for horizontal and vertical loads by portal method.
15. Understand and compare the different methods to analyze plane frames.
16. Apply the stiffness method to continuous beams, pin-joint frames and portal frames.
17. Construct the influence line diagrams for indeterminate beams using Muller-Breslau principle.
18. Apply the Castigliano's second theorem to evaluate forces in members of indeterminate trusses.
19. Evaluate the shear force and bending moment at a section of an indeterminate beam under moving load.
20. Construct the influence line diagram for the entire beam.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Level	Proficiency assessed by
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	H	Assignments, Exams
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	H	Assignments, Exams
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	-	-
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	-	-
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	-	-
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	-	-
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	-	-
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	-	-

PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	-	-
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	S	Assignments, Discussions, Exams
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	-	-
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	-	-

S – Supportive **H - Highly Related**

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**ENGINEERING KNOWLEDGE:** Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication.	H	Assignments, Exams
PSO2	**BROADNESS AND DIVERSITY:** Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage.	-	-
PSO3	**SELF-LEARNING AND SERVICE:** Graduates will be motivated for continuous self-learning in engineering practice and/or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly.	-	-

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IX. SYLLABUS:

UNIT – I

MOMENT DISTRIBUTION METHOD – Analysis of single bay - single storey portal frames including side sway. Analysis of inclined frames

KANI'S METHOD: Analysis of continuous beams including settlement of supports. Analysis of single bay single storey and single bay two storey frames by Kani's method including side sway. Shear force and bending moment diagrams. Elastic curve.

UNIT – II

SLOPE DEFLECTION METHOD – Analysis of single bay - single storey portal frames by slope deflection method including side sway. Shear force and bending moment diagrams. Elastic curve.

TWO HINGED ARCHES: Introduction – Classification of two hinged arches – Analysis of two hinged parabolic arches – secondary stresses in two hinged arches due to temperature and elastic shortening of rib.

UNIT-III

APPROXIMATE METHODS OF ANALYSIS: Analysis of multi-storey frames for lateral loads: Portal method, Cantilever method and Factor method. Analysis of multi-storey frames for gravity (vertical) loads. Substitute frame method. Analysis of Mill bends.

UNIT –IV

MATRIX METHODS OF ANALYSIS: Introduction - Static and Kinematic Indeterminacy - Analysis of continuous beams including settlement of supports, using Stiffness method. Analysis of pin-jointed determinate plane frames using stiffness method – Analysis of single bay single storey frames including side sway, using stiffness method. Analysis of continuous beams up to three degree of indeterminacy using flexibility method. Shear force and bending moment diagrams. Elastic curve.

UNIT – V

INFLUENCE LINES FOR INDETERMINATE BEAMS: Introduction – ILD for two span continuous beam with constant and variable moments of inertia. ILD for propped cantilever beams.

INDETERMINATE TRUSSES: Determination of static and kinematic indeterminacies – Analysis of trusses having single and two degrees of internal and external indeterminacies – Castigliano's second theorem.

TEXT BOOKS:

1. Structural Analysis Vol – I & II by Vazrani and Ratwani, Khanna Publishers
2. Structural Analysis Vol – I & II by Pundit and Gupta, Tata McGraw Hill Publishers
3. Structural Analysis SI edition by Aslam Kassimali, Cengage Learning Pvt. Ltd

REFERENCES:

1. Matrix Analysis of Structures by Singh, Cengage Learning Pvt. Ltd
2. Structural Analysis by Hibbler
3. Basic Structural Analysis by C.S. Reddy, Tata McGraw Hill Publishers
4. Matrix Analysis of Structures by Pundit and Gupta , Tata McGraw Hill Publishers
5. Advanced Structural Analysis by A.K. Jain, Nem Chand Bros.
6. Structural Analysis – II by S.S. Bhavikatti, Vikas Publishing House Pvt. Ltd.

X. COURSE PLAN:

At the end of the course, the students are able to achieve the following course learning outcomes:

Lecture No.	Topics to be covered	Course Learning Outcomes	References
1-2	Review of key concepts of previous courses useful for this course.	**Recall** the concepts and results of fixed-end moments for rotation and displacement of joints	R6: 1.1
4-8	**UNIT-I** **A. Moment Distribution method:** (a) single storey portal frames w/o sway (b) single storey portal frames with sway (c) inclined portal frames with sway	**Understand** working methodology of the moment distribution method. **Solve** for joint moments in frames. **Construct** the SF and BM diagrams for full frame.	R6: 2.9 – 2.11
9-12	**B. Kani's method of Analysis:** (a) Introductory concepts (b) analysis ofcontinuous beams (c) continuous beams with support settlements	**Understand** working methodology of Kani's method and **compare** that with moment distribution method. **Solve** for joint moments in continuous beams.**Construct** the SF and BM diagrams for full frame.	R6: 3.1 – 3.3
13-17	**B. Kani's method of Analysis:** (a) single bay - single storey frames (b) single bay - two storey frames (c) single bay frames with sway	**Understand** working methodology of Kani's method and **compare** that with moment distribution method.S**olve** for joint moments in frames.**Construct** the SF and BM diagrams for full frame.	R6: 3.3 – 3.5
18-24	**UNIT-II** **A. Slope Deflection method:** (a) single storey portal frames w/o sway (b) single storey portal frames with sway	**Understand** working methodology of Slope-deflection method and **compare** that with the previous two methods. **Solve** for joint moments in frames. **Construct** the SF and BM diagrams for full frame.	R6: 1.1 – 1.5
25-29	**UNIT-II** **B. Two hinged arches:** (a) Introduction, classification (b) Analysis of Parabolic arches (c) Secondary stresses	Know to **classify** various arches. **Understand** the indeterminacy in analysis of two-hinged arches. Learn to **analyze** the parabolic arches for the shear forces and bending moments	R6: 7.1 – 7.10
30-38	**UNIT-III** **Approximate methods of Analysis:** (a) Analysis for lateral loads - Portal (b) Cantilever method (c) Gravity loads – Substitute frame method	**Explain** the concept of approximate method of analysis of plane frames and their advantages for quick analysis. **Understand** and **compare** the different **methods** to analyze plane frames.	R6: 6.1 – 6.4
39-45	**UNIT-IV** **Matrix Methods of Analysis:** (a) Introduction (b) Static and Kinematic indeterminacy	**Explain** the concept of matrix method of analysis for framed structures. **Understand** and**explain** the different between static and kinematic indeterminacy.	R6: 11.1 – 11.5
46-51	**UNIT-IV** **Stiffness Method of Analysis:** (a) Continuous beams (b) Continuous beams with settlements of supports	Learn to **analyse** framed structures by stiffness method. **Apply** the method to continuous beams, pin-joint frames and portal frames.	R6: 11.8 – 11.9

	(c) Pin- Jointed plane frames (d) single-bay, single storey frames (e) frames with side sway		
52-57	**UNIT-IV** **Flexibility Method of Analysis:** (a) Stiffness vs Flexibility matrices (a) Continuous beams (b) Continuous beams with 3 DOI	Learn to **analyse** framed structures by flexibility method. **Apply** the method to continuous beams.	R6: 11.6 – 11.7
58-65	**UNIT-V** **A. Influence lines for Indeterminate beams:** (a) Introduction (b) 2-span beams with constant moment of inertia (c) 2-span beams with variable moments of inertia	**Evaluate** the shear force and bending moment at a section of an indeterminate beam under moving load. **Construct** the influence line diagram for the entire beam.	R6: 5.1 – 5.3
66-70	**B. Indeterminate Trusses:** (a) Introduction (b) Determination of static and kinematic indeterminacies	**Understand** and **explain** the static and kinematic indeterminacies in plane trusses	T1: 10.1-4
70-74	**B. Indeterminate Trusses:** (a) Analysis with 1D - indeterminacies (b) Analysis with 2D – indeterminacies (c) Application of Castigliano's theorem	**Solve** problems with 1 and 2 degrees of indeterminacy. **Apply** Castigliano's theorem to solve for such cases.	T1: 10.5-9

XI. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I	H														H
II		H													
III						H									
IV				S											
V						S								H	
VI			H										H		

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XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1.	H														
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17.	S														
18.													H		
19.		S													
20.													H		

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