



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

CIVIL ENGINEERING

COURSE DESCRIPTOR

Course Title	ADVANCED STRUCTURAL ANALYSIS AND DESIGN				
Course Code	ACE016				
Programme	B.Tech				
Semester	VII				
Course Type	Core				
Regulation	IARE - R16				
Course Structure	Theory			Practical	
	Lectures	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Chief Coordinator	Mr. Ashok Kumar, Assistant Professor				
Course Faculty	Mr. Ashok Kumar, Assistant Professor Dr. Venu M, Professor				

I. COURSE OVERVIEW:

The course focuses on advanced structural analysis of structures and design. Entire course is divided into two parts. Part one of the course includes the matrix methods of analysis like stiffness method and flexibility method. This includes the analysis of continuous beams, fixed beams, and single storey single bay frames. Apart from these, this course covers the approximate methods of analysis for structures subjected to horizontal and vertical loads. Part two the course covers the advanced structural design. This includes design of retaining walls, design deep foundations like pile foundations, design of flat slabs, design of water tanks, design of bunkers and silos. The main objective is to enable the student to have a good grasp of all the fundamental issues in these advanced topics in structural analysis, besides enjoying the learning process, and developing analytical and intuitive skills.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	ACE008	V	Structural Analysis	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Advanced Structural Analysis and Design	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✗	Chalk & Talk	✓	Quiz	✓	Assignments	✗	MOOCs
✓	LCD / PPT	✗	Seminars	✗	Mini Project	✗	Videos
✗	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with “either” or “choice” will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz / Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory		Total Marks
	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1	Presentation on real-world problems
PO 2	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	1	Assignments
PO 3	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.	1	Guest Lectures

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	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	1	Presentation on real-world problems
PSO 2	Broadness and diversity: Graduates will have a broad understanding of economic, 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.	-	-
PSO 3	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.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES :

The course should enable the students to:	
I	Enhance knowledge of matrix stiffness and flexibility methods for analyzing continuous beams, portal frames and trusses.
II	Design advanced structures such as retaining walls against lateral earth pressure.
III	Analyze and design the different types of piles and flat slabs as per the recommendations of Indian Standard codes.
IV	Explore and interpret the basic design concepts of water tanks, silos and bunkers.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Understand the basic concepts of static and kinematic indeterminacy. Know the concepts of stiffness method and flexibility method and analysis of various structural elements using these methods.	CLO 1	Understand the concepts of static and kinematic indeterminacy.
		CLO 2	Know the concepts of stiffness method and flexibility method.
		CLO 3	Analysis of continuous beam with and without settlement of supports using stiffness method.
		CLO 4	Analysis of single storey portal frames including side sway using stiffness method.
		CLO 5	Analysis of pin jointed determinate plane frames using stiffness method.
		CLO 6	Analysis for continuous beams up to three degree of indeterminacy using flexibility method

COs	Course Outcome	CLOs	Course Learning Outcome
CO 2	Understand the concepts of different approximate methods of analysis for lateral loads. Analysis of multi storey frame using portal method, cantilever method and substitute frame method.	CLO 7	Understand the concepts of different approximate methods of analysis for lateral loads.
		CLO 8	Analysis of multi storey frame using portal method.
		CLO 9	Analysis of multi storey frame using cantilever method.
		CLO 10	Analysis of multi storey frame using substitute frame method.
CO 3	Know the design concepts and IS code provisions for the retaining walls and water tanks. Design retaining walls and water tanks.	CLO 11	Know the design concepts and IS code provisions for the retaining walls and water tanks.
		CLO 12	Understand the design of retaining walls.
		CLO 13	Understand the design of water tanks.
CO 4	Know the design concepts and IS code provisions for the flat slabs and deep foundations. Design of flat slab, raft foundation and pile foundation.	CLO 14	Know the design concepts and IS code provisions for the flat slabs and deep foundations.
		CLO 15	Understand the design of flat slab.
		CLO 16	Understand the design of raft foundation.
		CLO 17	Understand the design of pile foundation.
CO 5	Know the design concepts and IS code provisions for the chimneys, bunker and silos. Design of chimneys, bunker and silos.	CLO 18	Know the design concepts and IS code provisions for the chimneys, bunker and silos.
		CLO 19	Understand the design of chimney.
		CLO 20	Understand the design of bunkers.
		CLO 21	Understand the design of silos.

X. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
ACE016.01	CLO 1	Understand the concepts of static and kinematic indeterminacy.	PO 1	2
ACE016.02	CLO 2	Know the concepts of stiffness method and flexibility method.	PO 1	2
ACE016.03	CLO 3	Analysis of continuous beam with and without settlement of supports using stiffness method.	PO 2	2
ACE016.04	CLO 4	Analysis of single storey portal frames including side sway using stiffness method.	PO 1	1
ACE016.05	CLO 5	Analysis of pin jointed determinate plane frames using stiffness method.	PO 2, PO 3	2
ACE016.06	CLO 6	Analysis for continuous beams up to three degree of indeterminacy using flexibility method	PO 3	2
ACE016.07	CLO 7	Understand the concepts of different approximate methods of analysis for lateral loads.	PO 1	2
ACE016.08	CLO 8	Analysis of multi storey frame using portal method.	PO 2, PO 3	2
ACE016.09	CLO 9	Analysis of multi storey frame using cantilever method.	PO 2, PO 3	2
ACE016.10	CLO 10	Analysis of multi storey frame using substitute frame method.	PO 1, PO 2	2
ACE016.11	CLO 11	Know the design concepts and IS code provisions for the retaining walls and water tanks.	PO 2, PO 3	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
ACE016.12	CLO 12	Understand the design of retaining walls.	PO 1	1
ACE016.13	CLO 13	Understand the design of water tanks.	PO 3	2
ACE016.14	CLO 14	Know the design concepts and IS code provisions for the flat slabs and deep foundations.	PO 1, PO 3	2
ACE016.15	CLO 15	Understand the design of flat slab.	PO 1	2
ACE016.16	CLO 16	Understand the design of raft foundation.	PO 1, PO 3	2
ACE016.17	CLO 17	Understand the design of pile foundation.	PO 2	2
ACE016.18	CLO 18	Know the design concepts and IS code provisions for the chimneys, bunker and silos.	PO 2, PO 3	2
ACE016.19	CLO 19	Understand the design of chimney.	PO 1	2
ACE016.20	CLO 20	Understand the design of bunkers.	PO 1, PO 3	2
ACE016.21	CLO 21	Understand the design of silos.	PO 1, PO 3	2

3= High; 2 = Medium; 1 = Low

XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (POs)			
	PO 1	PO 2	PO 3	PSO1
CO 1	1	2	1	1
CO 2	2	1	2	1
CO 3	1	2	1	1
CO 4	2		1	1
CO 5	1	2	1	1

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

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	2												1		
CLO 2	2												2		
CLO 3		2											1		

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 4	1												1		
CLO 5		2	1										2		
CLO 6			2												
CLO 7	2												2		
CLO 8		1	2										1		
CLO 9		1	2												
CLO 10	2	1											2		
CLO 11		2	1										1		
CLO 12	1												1		
CLO 13			2												
CLO 14	2		1										2		
CLO 15	2														
CLO 16	2		1										1		
CLO 17	2												1		
CLO 18		2	1										1		
CLO 19	2												1		
CLO 20	1		1										1		
CLO 21	1		1										2		

3 = High; 2 = Medium; 1 = Low

XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2, PO3, PSO1	SEE Exams	PO1, PO2, PO3, PSO1	Assignments	PO1, PO2, PO3, PSO1	Seminars	-
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XIV. ASSESSMENT METHODOLOGIES - INDIRECT

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✗	Assessment of Mini Projects by Experts		

XV. SYLLABUS

UNIT-I	MATRIX METHODS OF ANALYSIS
Static and kinematic indeterminacy, stiffness and flexibility methods; Stiffness method of analysis for continuous beams including settlement of supports; Single storey portal frames including side sway, pin jointed determinate plane frames; Flexibility method of analysis for continuous beams up to three degree of indeterminacy.	
UNIT -II	APPROXIMATE METHODS OF ANALYSIS
Analysis of multi-storey frames for lateral loads: Portal method and cantilever method; Analysis of multi storey frames for gravity (vertical) loads; Substitute frame method.	
UNIT -III	DESIGN OF RETAINING WALLS AND TANKS
Design of retaining walls, Design of water tanks. Design concepts and IS code provisions.	
UNIT -IV	DESIGN OF SLABS AND FOUNDATIONS
Design of flat slabs, Design of raft and pile foundations; Design concepts and IS code provisions.	
UNIT -V	DESIGN OF CHIMNEY, BUNKER AND SILOS
Design of chimneys, Design of bunkers and silos; Design concepts and IS code provisions.	
Text Books:	
<ol style="list-style-type: none"> 1. G S Pundit and S P Gupta, "Structural Analysis: A Matrix Approach", Mc Graw Hill Education Publishers, 2nd Edition, 2008. 2. S S Bhavikatti, "Structural Analysis- II", Vikas Publishing House Pvt. Ltd., 3rd Edition, 2009. 3. Varghese, "Advanced reinforced concrete structures", Prentice Hall of India Pvt. Ltd, 2009. 4. Pillai and Menon, "Reinforced Concrete Design", Tata McGraw-Hill Publishing Company, 2009. 	
Reference Books:	
<ol style="list-style-type: none"> 1. Devdas Menon, "Structural Analysis", Narosa Publishing House, 2nd Edition, 2008. 2. Devdas Menon, "Advanced Structural Analysis", Narosa Publishing House, 2nd Edition, 2009. 3. C S Reddy, "Basic Structural Analysis", Tata McGraw-Hill Education, 2001. 4. B C Punmia, Ashok Kumar Jain and Arun Kumar Jain, "Reinforced Concrete Structures", Vol. 2, Laxmi Publications, 2012. 	

XVI. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Understand the concepts of static and kinematic indeterminacy.	CLO 1	T1:1.1-1.7
2-4	Know the concepts of stiffness method and flexibility method.	CLO 2	T1: 4.1-4.5
5-9	Analysis of continuous beam with and without settlement of supports using stiffness method.	CLO 3	T1: 5.1-5.4
10-13	Analysis of single storey portal frames including side sway using stiffness method.	CLO 4	T1: 6.1-6.8
14-16	Analysis of pin jointed determinate plane frames using stiffness method.	CLO 5	T1: 7.1-7.6
17-20	Analysis for continuous beams up to three degree of indeterminacy using flexibility method.	CLO 6	T1: 5.2; 6.2
21	Understand the concepts of different approximate methods of analysis for lateral loads.	CLO 7	T2: 6.1
22-24	Analysis of multi storey frame using portal method.	CLO 8	T2: 6.3
25-27	Analysis of multi storey frame using cantilever method.	CLO 9	T2: 6.3
28-30	Analysis of multi storey frame using substitute frame method.	CLO 10	T2: 6.2

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
31	Know the design concepts and IS code provisions for the retaining walls and water tanks.	CLO 11	T3: 26.1-26.3
32-34	Understand the design of retaining walls.	CLO 12	T4: 14.7-14.8
35-37	Understand the design of water tanks.	CLO 13	T3: 26.5-26.10
38	Know the design concepts and IS code provisions for the flat slabs and deep foundations.	CLO 14	T3: 10.1
39-42	Understand the design of flat slab.	CLO 15	T3: 10.2-10.8
43-46	Understand the design of raft foundation.	CLO 16	T4: 14.1-14.3
47-50	Understand the design of pile foundation.	CLO 17	T4: 14.4-14.6
51	Know the design concepts and IS code provisions for the chimneys, bunker and silos.	CLO 18	T3: 2.1
52-55	Understand the design of chimney.	CLO 19	T3: 3.1-3.12
56-60	Understand the design of bunkers.	CLO 20	T3: 2.2-2.7
61-64	Understand the design of silos.	CLO 21	T3: 2.8-2.13

XVII. GAPS IN THE SYLLABUS-TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed Actions	Relevance With POs	Relevance With PSOs
1	Analysis of multistoried buildings.	Seminars/ Guest Lectures/ NPTEL	PO 2	PSO 1
2	Application of matrix method in pin jointed space frames.	Seminars/ Guest Lectures/ NPTEL	PO 2, PO3	PSO 1
3	Application of earthquake loads to the multistoried frames.	Seminars/ Assignments	PO 2, PO 3	PSO 1

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