INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

CIVIL ENGINEERING

COURSE DESCRIPTOR

Course Title	**FOUNDATION ENGINEERING**				
Course Code	ACE018				
Programme	B.Tech				
Semester	VIII	CE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Ms.U. Deepthi, Assistant professor				
Course Faculty	Mr. N. Venkat Rao, Associate Professor Ms.U. Deepthi, Assistant professor Ms. V.Alivelu manga, Assistant professor				

I. COURSEOVERVIEW:

Civil Engineers are required to construct structures on the soil. The loads coming onto these structures, along with the self-weight, have to be safely transmitted to the soil beneath it. A geotechnical engineer must be able to design a footing in such a way that soil below it will not fail there will not be any excessive settlements in the soil. This course enables students to design a shallow and deep foundation, analyze the stability of slopes, and check the stability of retaining walls and embankments against failure. Through this course content engineers can design the foundation for safety andserviceability.

II. COURSEPRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	ACE003	III	Engineering Geology	4
UG	ACE006	IV	Geotechnical Engineering	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Foundation Engineering	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V. EVALUATIONMETHODOLOGY:

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 aquestion.

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**
Type of Assessment	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 CIEexams.

Quiz / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are 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 AREASSESSED:

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 engineeringproblems.	1	Assignments/ Exams
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	2	Assignments/ Exams
PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs withappropriate Consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Assignments/ Exams
PO 6	**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.	2	Assignments/ Exams

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES AREASSESSED:

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.	2	Assignments/ Exams
PSO 2	**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.	-	-
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(COs):

The course should enable the students to:	
I	Understand various methods of soil exploration and field tests on soil, planning and preparation of soil investigation programme.
II	Analyze the stability of infinite and finite slopes
III	Calculate At rest, Active and Passive earth pressures of soil & Analyze the stability of retaining wall against sliding, overturning and bearing capacity failures.
IV	Calculate the bearing capacity of shallow and deep foundation from theoretical & field tests.

IX. COURSE OUTCOMES(COs):

Cos	Course Outcome	CLOs	Course Learning Outcome
CO 1	Understand the need and various methods of soil exploration, planning and preparation of soil investigation report	CLO 1	Understand the need and methods of Soil Exploration
		CLO 2	Understand various methods of sampling and boring
		CLO 3	Learn how to perform field tests such as SPT, DCPT,CPT
		CLO 4	Learn how to perform Plate Load test for finding load bearing capacity, settlements of soils.
		CLO 5	Understand the importance of geophysical methods and Learn how to prepare Soil investigation Report.
CO 2	Analyze the stability of slopes by various methods	CLO 6	Analyze failure of infinite slopes and Analyze types of failures for finite slopes.
		CLO 7	Learn how to find Stability of slopes by Swedish arc Method and by Method of Slices.
		CLO 8	Find Stability of slopes by Taylor's Stability number
		CLO 9	Learn how to find stability of slopes by Bishops method.
		CLO 10	Understand basic concepts of Stability of slopes of earth dam under different conditions.
CO 3	Understand various earth pressure theories and stability of retaining walls at various conditions	CLO 11	Understand concepts of earth pressure theories for stability of Retaining walls
		CLO 12	Calculate active and passive earth pressures from Rankine's earth pressure theories
		CLO 13	Calculate active and passive earth pressures from Coulomb's & Culmann's Method
		CLO 14	Asses the stability of retaining wall against overturning,sliding, bearing capacity.
		CLO 15	Understand the concepts of safe bearing capacity, ultimate bearing capacity etc.,
CO 4	Understand shallow and deep foundations according to various bearing capacity theories and analyze Pile foundations in various different soils	CLO 16	Calculate the bearing capacity of shallow foundation using Terzaghi, Meyerhof, Skempton and IS Methods.
		CLO 17	Calculate the load carrying capacity of pile using static,dynamic pile formula and pile load test
		CLO 18	Calculate load carrying capacity of pile group in sandsand clay.
		CLO 19	Calculate settlement of pile group.
		CLO 20	Understand the stability of foundations on expansive soils and marine soils.
CO 5	Understand various shapes and components of wells and analyze, design according to IRC guidelines	CLO 21	Learn different shapes of well & components of Well Foundation
		CLO 22	Understand shrinking of well, tilts and shifts.
		CLO 23	Analyze various forces acting on well.
		CLO 24	Understand the principle of analysis and design ofwells, Seismic analysis and IRC guidelines.

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
ACE018.01	CLO 1	Understand the need and methods of Soil Exploration	PO 3	2
ACE018.02	CLO 2	Understand various methods of sampling and boring	PO 3	1
ACE018.03	CLO 3	Learn how to perform field tests such as SPT, DCPT, CPT	PO 3, PO 6	2
ACE018.04	CLO 4	Learn how to perform Plate Load test for finding load bearing capacity, settlements of soils	PO 3	2
ACE018.05	CLO 5	Learn how to perform in-situ test using pressure meter	PO 3	3
ACE018.06	CLO 6	Understand the importance of geophysical methods	PO 3, PO 6	2
ACE018.07	CLO 7	Learn how to prepare Soil investigation Report	PO 3	1
ACE018.08	CLO 8	Understand basic concepts of earth slopes	PO 3, PO 6, PO 1	2
ACE018.09	CLO 9	Analyze failure of infinite slopes	PO 3, PO 6, PO 1	2
ACE018.10	CLO 10	Analyze types of failures for finite slopes	PO 3, PO 6, PO 1	2
ACE018.11	CLO 11	Learn how to find Stability of slopes by Swedish arc Method	PO 3, PO6, PO 1, PO2	2
ACE018.12	CLO 12	Learn how to find Stability of slopes by Method of Slices for slopes	PO 3, PO6, PO 1, PO2	2
ACE018.13	CLO 13	Find Stability of slopes by Taylor's Stability number	PO 3, PO6, PO 1, PO2	2
ACE018.14	CLO 14	Understand basic concepts of Stability of slopes of earth dam under different conditions	PO 3, PO 2	2
ACE018.15	CLO 15	Understand concepts of earth pressure theories for stability of Retaining walls	PO 2, PO 3	2
ACE018.16	CLO 16	Calculate active and passive earth pressures from Rankine's earth pressure theories	PO 1, PO 2, PO 3	2
ACE018.17	CLO 17	Calculate active and passive earth pressures from Coulomb's &Culmann's Method	PO 1, PO 2, PO 3	2
ACE018.18	CLO 18	Asses the stability of retaining wall against overturning, sliding, bearing capacity	PO 2, PO 3, PO 6	2
ACE018.19	CLO 19	Understand the concepts of safe bearing capacity, ultimate bearing capacity etc.,	PO 2, PO 3, PO 6	2
ACE018.20	CLO 20	Calculate the bearing capacity of shallow foundation using Terzaghi, Meyerhof, Skempton and IS Methods.	PO 1, PO2, PO 3, PO6	2
ACE018.21	CLO 21	Calculate the load carrying capacity of pile using static, dynamic pile formula and pile load test	PO 3, PO 6	2
ACE018.22	CLO 22	Calculate load carrying capacity of pile group in sands and clay & settlement of pile group	PO 1, PO2, PO 3, PO6	2
ACE018.23	CLO 23	Learn different shapes of well & components of Well Foundation	PO 1, PO 3	1
ACE018.24	CLO 24	Understand the principle of analysis and design of wells, Seismic analysis and IRC guidelines	PO 3, PO 6	2

3 = High; 2 = Medium; 1 = Low

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

Course Outcomes (COs)	Program Outcomes (POs)				Programme specific outcomes(PSOs)
	PO 1	PO 2	PO 3	PO 6	PSO1
CO 1			2	2	2
CO 2	2		2	3	2
CO 3	2	2	2	3	2
CO 4	2	2	3	2	2
CO 5	2	2	3	2	2

3 = High; 2 = Medium; 1 = Low

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

CLO	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										2		
CLO 2			1										2		
CLO 3			2			2							3		
CLO 4			2										3		
CLO 5			3										3		
CLO 6			2			2							2		
CLO 7			1										2		
CLO 8	2		2			3							3		
CLO 9	2		2			2							3		
CLO 10	3		2			3							2		
CLO 11	1	2	2			3							3		
CLO 12	2	3	2			2							2		
CLO 13	3	3	2			3							3		
CLO 14		2	3										1		
CLO 15		2	3										2		
CLO 16	2	3	2										3		
CLO 17	2	3	2										3		

CLO	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 18		2	3			2							1		
CLO 19		2	3			3							2		
CLO 20	1	2	3			2							3		
CLO 21			3			2							2		
CLO 22	1	2	3			3							2		
CLO 23	2		1										1		
CLO 24			3			2							2		

3=High; 2 = Medium; 1 = Low

XIII. ASSESSMENT METHODOLOGIES –DIRECT

CIE Exams	PO 1,PO2, PO3,PO6, PSO1	SEE Exams	PO 1,PO2, PO3,PO6, PSO1	Assignments	PO 1, PO 2	Seminars	PO 3
Laboratory Practices	-	Student Viva	-	Mini Project	PO 1, PO 3, PO 6	Certificatior	-
Term Paper	-						

XIV. ASSESSMENT METHODOLOGIES -INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XV. SYLLABUS

Unit-I	SOIL EXPLORATION
Need and methods of soil exploration, boring and sampling methods, pits and trenches, drifts and shafts, methods of boring, auger borings, wash borings, rotary drilling, percussion drilling, core drilling, types of soil samples, disturbed samples, undisturbed samples, design features affecting the sample disturbance, split spoon samplers, scraper bucket samplers, shell by tubes and thin walled samplers, piston samplers, preservation and handling of samples. penetration tests, monotonic and cyclic, field permeability tests, insitu tests using pressure meter, observation of ground water table, instrumentation insoilengineering,straingauges,resistanceandinductancetypeplateloadtest,pressuremeter, geophysical methods, planning of programme and preparation of soil investigation report.	
Unit-II	**SLOPE STABILITY**
Infinite and finite earth slopes, types of failures, factor of safety of infinites lopes, stability analysis by Swedish arc method, standard method of slices, Bishop's Simplified method, Taylor's Stability number, and stability f slopes of earth dams under different conditions	
Unit-III	**EARTH PRESSURE THEORIES AND RETAINING WALLS**
Rankine's theory of earth pressure, earth pressures in layered soils, Coulomb's earth pressure theory, Culmann's graphical method.Types of retaining walls, stability of retaining walls against overturning, sliding, bearing capacity and drainage from backfill.	

Unit-IV	SHALLOW AND DEEP FOUNDATIONS
Types, choice of foundation, location of depth, safe bearing capacity, Terzaghi, Meyerhof, Skemptonand IS Methods. Safe bearing pressure based on N value, allowable bearing pressure, safe bearing capacity, plate load test, allowable settlements of structures, Analysis of foundation, individual, strip, combined footingsandmatfoundationsconventional,elasticapproach,soilstructureinteractionprinciples.Typesof piles, load carrying capacity of piles based on static pile formulae in dynamic pile formulae, pile load tests,loadcarryingcapacityofpilegroupsinsandsandclays,settlementofpilegroups.Introductionto foundations on expansive soils and marine foundations.	
Unit-V	**WELL FOUNDATIONS**
Different shapes of wells, components of well, sinking of well, tilts and shifts, principles of analysis and design, seismic influences, IRC guidelines	
Text Books:	
1. B. M. Das, "Principles of foundation engineering" Cengage Learning,2012. 2. GopalRanjan and A.S.R. Rao , "Basic and applied soil mechanics" New age international Pvt. Ltd. 2004. 3. V.N.S Murthy ,"Geotechnical Engineering: Principles and practices of soils mechanics and foundation engineering", Taylor & Francis Group,2002.	
Reference Books:	
1. C. Venkataramiah, "Geotechnical engineering", New Age International Pvt. Ltd,2002. 2. Manojdutta and Gulati, "Geotechnical engineering", Tata McGrawhill publishers New Delhi,2005. 3. K.R .Arora, "Soil mechanics and foundation engineering", standard publishers and distributors,New Delhi, 2005. 4. B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, "Soil mechanics and foundation", Laxmi publications Pvt. Ltd, New Delhi,2005.	
Web References:	
1. http://nptel.ac.in/courses/105107120/1# 2. https://ocw.mit.edu/courses/civil,and,environmental,engineering/1,364,advanced,geotechnical,engineering,fall,2003/index.html	

XVI. COURSEPLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Introduction to Soil Exploration	CLO 1	T1:1.1, R2:2.2
3	Methods of soil Exploration	CLO 1	T1:1.4, R2:2.3
4	Types of Boring	CLO 2	T:6.6, R2:2.6
5-6	Soil Sampling methods	CLO 2	T1:3.1, R2:2.8
7	Standard Penetration test (SPT)	CLO 4	T3:3.15,R2:2.9
8-9	Plate Load test	CLO 3	T1:3.3, R2:2.10
10-11	In-situ test using a pressure meter	CLO 3	T1:3.8, R2:2.11
12-13	Planning & Preparation of Soil investigation report	CLO 4	T1:3.9, R2:2.12
14	Introduction to infinite and finite earth slopes	CLO 3	T1:4.3, R2:2.13
15-16	Types of failures	CLO 5	T1:5.9, R1:3.1
17-18	FOS of infinite slopes	CLO 5	T1:5.4, R1:3.2
19-20	Stability Analysis by Swedish arc Method	CLO 6	T1:5.4.1, R1:3.3
21-22	Method of Slices for Analysis of finite slopes	CLO 7	T1:5.6, R1:3.4

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
23-24	Bishop's Simplified method	CLO 8	T1:5.8, R1:3.4.1
25-26	Taylor's Stability number	CLO 12	T1:6.9 to 6.10, R1:3.5
27	Stability of slopes of earth dam under different conditions	CLO 11	T1:6.5, R1:3.5.2
28-30	Introduction to earth pressure theories	CLO 13	T1:6.3 , R1:3.6
31	Rakine's earth pressure theories	CLO 14	T1:7.22, R2:4.6
32-34	Columb's earth pressure theories	CLO 15	T1:7.22, R2:4.7
35-37	Culman's graphical method	CLO 16	T1:12.6.1, R1: 4.1
38	Introduction and types of Retaining walls	CLO 16	T1:12.6.2, R1: 4.1.2
39-40	Stability of Retaining walls against overturning, Sliding, bearing capacity.	CLO 17	T1:12.6.2, R1: 4.2
41-42	Drainage for Backfill	CLO 17	T1:12.6.2, R1: 4.3
43-44	Introduction to Shallow foundations	CLO 17	T1:12.6.3, R1: 4.4
45-46	Depth of foundation	CLO 18	T1:7.4, R1: 6.1
47-49	Safe bearing capacity	CLO 19	T1:10.2.1, R1: 6.4
50-52	Terzaghi Method	CLO 19	T1:10.2.4, R1: 6.6
53-54	Meyerhof Method	CLO 18	T1:10.7, R1: 6.7
55-57	Skempton Method	CLO 20	T1:8.4.2, R2: 8.1
58-60	IS Code methods for bearing capacity	CLO 21	T1:8.8, R2: 8.2
61-62	Safe bearing pressure based on N- Value, Allowable bearing pressure & Settlements, plate load test	CLO 21	T1:8.12.2, R2: 8.2.4
63-64	Introduction to Well foundation and there types	CLO 23	T1:8.11.3, R2: 8.4
65-66	Different shapes of wells & Components of Wells	CLO 23	T1:8.11.2, R2: 8.5
67-68	Sinking of Wells & Measures for rectification of tilts and Silts	CLO 24	T1:8.12, R2: 8.6

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Different Methods to increase the stability of slopes	Seminars/Guest Lectures/NPTEL	PO 3	PSO 1
2	Determination of Active and passive earth pressure by friction circle method	Seminars/Guest Lectures/NPTEL	PO 2	PSO 1
3	Design of foundation for expansive soils	Seminars/NPTEL	PO 3	PSO 1

Prepared by:

Ms.U.Deepthi, Assistant Professor HOD, CE
Mr. N. Venkat Rao, Associate Professor