INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomus)
Dundigal, Hyderabad -500 043

CIVIL ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**GROUND IMPROVEMENT TECHNIQUES**			
Course Code	**A60127**			
Regulation	**R15-JNTUH**			
Course Structure	**Lectures**	**Tutorials**	**Practicals**	**Credits**
	4	**1**	**-**	**4**
Course Coordinator	**Dr. Kavita Singh, Associate Professor, Civil Engineering.**			
Team of Instructors	**Dr. Kavita Singh Associate Professor** **Ms. J. Hymavathi, Assistant Professor**			

I. COURSE OVERVIEW:

The most common traditional objectives include improvement of the soil and ground for use as a foundation or construction material. The typical Engineering objectives have been: Increasing shear strength, durability, stiffness, stability, mitigating undesirable properties (eg. Shrink/ swell potential, compressibility, modifying permeability, the rate of fluid to flow through a medium; and Improving efficiency and productivity by using methods that save time and expense, The engineer must take a determination on how best to achieve the desired goals required by providing a workable solution for each project encountered. Ground improvement methods have provided adverse choice of approaches to solving these challenges.

II. PREREQUISITES:

Level	Credits	Periods / Week	Prerequisites
UG	4	4	Geotechnical Engineering

III. MARKS DISTRUBUTION:

Session Marks	University End Exam Marks	Total Marks
Mid Semester 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 of 20 minutes 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 portion. **Assignment** Five marks are earned for assignments. There shall be two assignments in every theory course. Marks shall be awarded considering the average of two assignments in each course.	75	100

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 objective of the teacher is to impart knowledge and abilities to the students to:

I. Apply knowledge on ground improvement techniques such as reinforced earth, drainage and dewatering and grouting techniques on stabilization of expansive soils.
II. Impart knowledge of mechanical modification techniques such as deep compaction, blasting, vibro-compaction, dynamic tamping and compaction Piles.
III. Design of dewatering system which is treated as one of the ground improvement technique.
IV. Familiarize with different ground improvement techniques for cohesive and granular soil.
V. Understand the concept of reinforced earth, geosynthetics and soil reinforcement in ground improvement.

VI. COURSE OUTCOMES:

After completing this course the student must demonstrate the knowledge and ability to:

1. Identify the type of problems in problematic soils and solve their problems using different ground improvement techniques
2. Understand the need of ground improvement for stable engineered structures using various techniques.
3. Understand the importance of vibro-compaction and compaction piles on in-situ densification of soil.
4. Understand deep compaction techniques- Dynamic Tamping and Compaction piles.
5. Understand traditional dewatering system methods.
6. Design drainage and dewatering systems for various civil engineering problems.
7. Application of dewatering methods using well point system and electro-osmotic methods.
8. Understand the importance of Preloading and sand drains in in-situ densification and 3 dimensional consolidations.
9. Application of physical and chemical ground improvement techniques using thermal modification, like grouting, shotcreting and guniting technology.
10. Application of thermal modification and Ground freezing and heating on ground improvement Techniques
11. Understand the ground improvement techniques such as ground anchors, rock bolting and soil nailing
12. Design of reinforced earth retaining structures.

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	H	Assignments/Exams

	literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.		
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.	H	Assignments/ Mini Projects
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.	S	Open ended experiments
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.	S	Seminars
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	Group Discussions/ Presentations
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	Seminars/Workshops

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	Lectures, Assignments, Exam
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.	S	Lectures, Assignments, Exam

Program Specific Outcomes		Level	Proficiency assessed by
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.	S	Lectures, Guest Lectures, Discussions, Industrial Visits

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IX. SYLLABUS:

UNIT-1

Introduction to ground Modification: Need and objectives, Identification of soil types, In Situ and laboratory tests to characterize problematic soils; mechanical, hydraulic, physico-chemical, Electrical, Thermal methods, and their applications.

UNIT-2

Mechanical Modification – Deep Compaction Techniques- Blasting vibrocompaction, Dynamic Tamping and Compaction piles.

UNIT-3

Hydraulic Modification- Objective and techniques, traditional dewatering methods and their choice, Design of dewatering system, electro-osmosis, electro kinetic dewatering. Filtration, Drainage and seepage control with geosynthetics, preloading the vertical drains.

UNIT-4

Physical and Chemical Modification- Modification by admixtures, shotcreting and Guniting Technology, Modification at depth by grouting, crack grounting and compaction grouting. Jet grouting, Thermal modification, Ground freezing.

UNIT-5

Modification by inclusions and confinement- Soil reinforcement, reinforcement with strip, and grid reinforced soil. In-situ ground reinforcement, and ground anchors, rock bolting and soil nailing.

TEXT BOOKS:

1. Hausmann, M.R. (1990) “Engineering principles of Ground Modifications,” Mcgraw Hill publications.

REFERENCES:

1. Koener, R.M (1994) “Designing with Geosynthetics,” Prentice Hall, New Jersey.
2. Jones C.J.P, (1985) “Earth Reinforcement and soil structures,” Butterworths, London.
3. Xianthakos, Abreimson and Bruce “Ground Control and Improvement,”

X. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No	Course Learning Outcomes	Topics to be covered	Reference
1	Understand the introduction of ground Modification:	Introduction to ground Modification:	T 1
2-5	Understand Need and objectives	Need and objectives	T 1
6-7	Identification of soil types	Identification of soil types	T 1
8-15	Understand In Situ and laboratory tests to characterize	In Situ and laboratory tests to characterize problematic soils;	T 1

Lecture No	Course Learning Outcomes	Topics to be covered	Reference
	problematic soils;		
16-17	Understand Mechanical , hydraulic, physic-chemical	Mechanical , hydraulic, physic-chemical	T 1
18-19	Application of Electrical, Thermal methods, and their applications.	Electrical, Thermal methods, and their applications.	T 1
20-22	Define Mechanical Modification	Mechanical Modification	T 1
23-24	Understand Deep Compaction Techniques	Deep Compaction Techniques	T 1
25-26	Application of Blasting vibrocompaction	Blasting vibrocompaction	T 1
27-28	Application Hydraulic Modification-	Hydraulic Modification-	T 1
29-30	Define Objective and techniques	Objective and techniques	T 1
31-32	Discuss traditional dewatering methods and their choice	traditional dewatering methods and their choice	T 1
33-34	Design of dewatering system	Design of dewatering system	T 1
35-36	Define electro-osmosis	electro-osmosis	T 1
37-38	Discuss electro kinetic dewatering	electro kinetic dewatering	T 1
39-40	Understand Filtration process	Filtration	T 1
41-42	Define Drainage and seepage control with geosynthetics,	Drainage and seepage control with geosynthetics,	T 1
43-44	Application of Preloading the vertical drains.	Preloading the vertical drains.	T 1
45-46	Define Physical and Chemical Modification-	Physical and Chemical Modification- shotcreting and Guniting Technology,	T 1
47-48	Understand Shotcreting and Guniting Technology,	Modification at depth by grouting, crack grouting and compaction grouting, Jet grouting	T 1
49-50	Understand Modification at depth by grouting,	Thermal modification, Ground freezing. Modification by inclusions and confinement-	T 1
51-52	Define crack grouting and compaction grouting	Soil reinforcement and grid reinforced soil.	T 1
53-54	Application Jet grouting	In-situ ground reinforcement and ground anchors	T 1
55-56	Apply Thermal modification, Ground freezing.	Rock bolting	T 1
57	Apply Modification by inclusions and confinement-	Soil nailing	T 1

XI. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF PROGRAM 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	H									S	H	H	S
II	H	H	S										H	H	S
III	H	H	S	S									S	H	S
IV	H	S											H	S	S
V		H							S	S			H		S

S= Supportive H = Highly Related

XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM 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	S	S						S	S		S	H	S	
2	H			S					S	S		S	S	H	
3		H							S	S		S	H	S	S
4	H	H	H						S	S		S	H	S	S
5	H	H	H						S	S		S	S		
6	H	H	H						S	S		S	H	S	
7	H	H							S	S		S	S		
8	H	H	H						S	S		S	H	S	S
9	H	H	H						S	S		S	H	S	S
10	H	H	H						S	S		S	H	S	S
11	H	H	H	S					S	S		S	H	S	S
12	H	H	H	S					S	S		S	H	S	S

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Prepared by:
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