Program : **Diploma in Civil Engineering**	
Course Code : **5014B**	Course Title: **Ground Improvement Techniques**
Semester : **5**	Credits: **3**
Course Category: **Program Core**	
Periods per week: **3** (**L:3, T:0, P:0**)	Periods per semester: **45**

Course Objectives:

- To impart the fundamental knowledge of Ground Improvement Techniques
- To develop the knowledge in the field of modification of ground required for construction of Civil engineering structures.
- To introduce the concepts of chemical compaction, grouting and other miscellaneous methods.
- Impart the knowledge of Geosynthetics, vibration, grouting and Injection.

Course Prerequisites:

Topic	Course code	Course name	Semester
Basics of soil mechanics		Geotechnical Engineering	4

Course Outcomes:

On completion of the course, the student will be able to:

COn	Description	Duration (Hours)	Cognitive level
CO1	Identify mechanical and hydraulic methods of ground improvement.	10	Applying
CO2	Identify methods of soil stabilization using admixtures and soil grouting	10	Applying
CO3	Identify different methods of reinforcing earth	12	Applying
CO4	Apply the consolidation characteristics of soil for ground improvement.	11	Applying
	Series test	2	

CO - PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2	3						
CO3					3		
CO4	3						

3-Strongly mapped, 2-Moderately mapped, 1-Weakly mapped

Course Outline:

Module Outcomes	Description	Duration (Hours)	Cognitive Level
CO1	**Identify mechanical and hydraulic methods of ground improvement.**		
M1.01	Identify general ground improvement techniques	3	Understanding
M1.02	Describe mechanical methods of ground improvement.	2	Understanding
M1.03	Identify Dewatering methods	2	Understanding
M1.04	Describe methods of dewatering for given site conditions.	3	Applying
Contents: General methods of ground improvement - Mechanism and Classification of ground improvement techniques. Field compaction mechanism - Moisture density relationship - Shallow surface compaction using rollers - Smooth wheel rollers, sheep foot rollers, pneumatic tyred rollers and grid rollers Drainage and dewatering: - well point system - single stage and multi stage well point system, shallow & deep well system, vacuum method, electro-osmosis method. Working of Stone columns.			
CO2	**Identify methods of soil stabilization using admixtures and soil grouting**		
M2.01	Identify methods of soil stabilizations	2	Understanding
M2.02	Compare cement & bitumen methods of stabilizations	3	Understanding
M2.03	Identify basic properties, functions and materials of soil grouting	2	Understanding
M2.04	Identify applications of soil grouting	3	Applying
	Series Test - I	1	

Contents:

Methods of soil stabilizations: by adding Cement and Bitumen only - comparison.

Define Chemical Grouting - basic functions - permeation - compaction - hydro fracture (definition only), classification of grouts - suspension grout and solution grout. Definition of properties of grouts - viscosity, stability, fluidity, rigidity, Thixotropy, permanence, - Groutability ratio.

Grouting applications - seepage control in soil and rock under dams - seepage control in soil for cut off walls.

CO3	**Identify reinforced soil and describe different methods of reinforcing earth**		
M3.01	Explain the soil reinforcement mechanism	3	Understanding
M3.02	Classify different types of reinforcement for soil	3	Understanding
M3.03	Identify constructional procedure for reinforced earth wall	3	Understanding
M3.04	Define and illustrate Geosynthetics and its applications.	3	Applying

Contents:

Define soil reinforcement, application of soil reinforcement (theory only). Types of soil reinforcements (definition only). Mechanism of soil reinforcement - Placement of reinforcement in soil - applications (list only) - Reinforced earth wall construction. Geosynthetics - definition, types & properties of geosynthetics - geotextile, geogrid, geomembrane, geocells and geotubes.

CO4	**Identify consolidation characteristics of soil**		
M4.01	Define consolidation and compare consolidation and compaction	3	Understanding
M4.02	Exemplify primary consolidation	3	Understanding
M4.03	Explain stages of consolidation and consolidation characteristics.	2	Understanding
M4.04	Identify methods of improving clay formations by accelerating consolidation	3	Applying
	Series Test - II	1	

Contents:

Definition of consolidation - comparison of compaction and consolidation - stages of consolidation Soil-Spring analogy of primary consolidation - laboratory consolidation test - e-log p curve - coefficient of consolidation - Preloading technique (brief discussion only). Vertical drains - Sand drains and Prefabricated vertical drains.

Text / Reference:

T/R	Book Title/Author
T1	P. PurushothamaRaj : Ground Improvement Technique ; Laxmi Publications (P) Ltd
R1	Dr.Arora.K.R : Soil Mechanics and Foundation Engineering ; Standard publishers
R2	Dr. J.Sha&S.K.sinha : Construction and Foundation Engineering ; Khanna Publishers
R3	Nihar Ranjan Patra : Ground Improvement Techniques ; Vikas Publishers
R4	P. PurushothamaRaj : Geotechnical Engineering ; Tata McGraw Hill

Online Resources:

Sl.No	Website Link
1	http://www.soilmanagementindia.com/consolidation
2	https://ascelibrary.org/doi/book/10.1061/9780784407837
3	http://www.builtconstructions.in/OnlineMagazine/BuiltConstructions/Pages/Grouting-for-Ground-Improvement-0337.aspx
4	https://theconstructor.org/practical-guide/methods-of-dewatering-excavation-construction-site/13849/
5	https://www.sciencedirect.com/topics/engineering/soil-stabilization