SYLLABUS

OF

M. TECH
(GEOTECHNICAL ENGINEERING)

I YEAR

(CBCS)

DEPARTMENT OF CIVIL ENGINEERING

INTEGRAL UNIVERSITY LUCKNOW

STUDY AND EVALUATION SCHEME

M.Tech. (Geotechnical Engineering)

(w.e.f. Batch 2024-25)

Semester – I

S. No.	Course Category	Code No	Name of Subject	Periods				Evaluation Scheme				Subject Total
				L	T	P	C	Continuous Assessment (CA)			Exam ESE	
								CT	TA	Total		
1	DC	CE581	Advance Soil Mechanics	3	1	-	4	40	20	60	40	100
2	DC	CE582	Clay Mineralogy and Expansive Soil	3	1	-	4	40	20	60	40	100
3	DC	CE583	Ground Improvement and Geosynthetics	3	1	-	4	40	20	60	40	100
4	DE	As per Annexure	Departmental Elective - I	3	1	-	4	40	20	60	40	100
5	DC	CE588	Soil Mechanics Lab	-	-	3	2	-	-	60	40	100
Total				**12**	**4**	**3**	**18**					**500**

Semester – II

S. No.	Course Category	Code No	Name of Subject	Periods				Evaluation Scheme				Subject Total
				L	T	P	C	Continuous Assessment (CA)			Exam ESE	
								CT	TA	Total		
1	DC	CE552	Research Methodology	3	1	-	4	40	20	60	40	100
2	DC	CE589	Site Investigation and Foundation Design	3	1	-	4	40	20	60	40	100
3	DC	CE590	Rock Engineering	3	1	-	4	40	20	60	40	100
4	DC	CE572	Research Paper Presentation and Discussion/Seminar	-	-	-	4	-	-	60	40	100
5	DC	CE591	Advanced Geotechnical Engineering Lab	-	-	3	2	-	-	60	40	100
Total				**9**	**3**	**3**	**18**					**500**

L – Lecture; **T –** Tutorial; **P –** Practical; **C** – Credits; **CT** – Class Tests; **TA** – Teacher Assessment
Continuous Assessment (CA) = Class Tests + Teacher Assessment

Subject Total = Continuous Assessment (CA) + End Semester Examination (ESE)

DC – Departmental Core **DE** – Departmental Elective

Departmental Elective – I

CE584 Applied Geology
CE585 Geo-environmental Engineering
CE586 Land Contamination and Remediation
CE587 Groundwater Hydrology

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	CE581	**Title of the Course**	Advance Soil Mechanics	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	• Analyze effective stress for different field conditions. • Calculate settlement of soils using one dimensional and three-dimensional consolidation theories. • Calculate earth pressure theories. • Develop stress path diagrams for different load conditions.						

Course Outcomes	
CO1	Students are able to Apply fundamental knowledge of the behavior of soil as an engineering material in Civil Engineering Projects.
CO2	Students will be able to determine the stress, strain of soil, critical state of soil.
CO3	Students are able to understand the mechanical stress, strain and strength of soil.
CO4	Students will be able to understand the difference between elastic and plastic behaviour of soil.
CO5	Students will learn to analyses and solve a range of soil-related problems, especially those involving water flow and soil settlement.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Structure and Mineralogy	Structure and composition of soil & clay minerals, effect of clay minerals on engineering properties, mechanics of expansive soil.	08	CO1
2	Stresses, Strains, and Deformations of Soils	Stresses within a soil mass: Concept of stress for a particulate system, Effective stress principle, Geostatic stresses, Soil water hydraulics: Principal stresses and Mohr's circle of stress, Stress paths; At Rest earth pressure, Stress paths for different practical situations.	08	CO2
3	Stress Distribution in Soil	Concentrated and distributed line loads: Boussinesq's equation and Westergaards's solution. Vertical pressure line and strip loads and loaded circular and rectangular areas. Limitations of elastic formulae for soils.	08	CO3
4	Elastic and Plastic State of Soil	Concept of elastic and plastic equilibrium, general states of plastic equilibrium. Dubrova's lateral earth pressure theories, Brinch-Hansens theory.	08	CO4
5	Shear Strength and Consolidation of Soil	Shear strength of cohesion less and cohesive soils, effective stress principle, Theory of consolidation, Time rate of consolidation, 3-D consolidation, immediate and ultimate settlements.	08	CO5

Reference Books:

Braja M.Das, "Advanced Soil Mechanics" Tata Mc.- Grawhill.

M. Budhu, "Soil Mechanics and Foundations", Wiley India Pvt. Ltd., New Delhi.

R.O. Davis and A.P.S. Selvadurai, "Elasticity and Geomechanics, Cambridge University, Press, New York.

R F Scott, "Principles of Soil Mechanics", Addison & Wesley.

e-Learning Source:

https://archive.nptel.ac.in/courses/105/103/105103207/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1	0	2	0	0	2	1	0	2	2	3
CO2	3	1	2	0	2	1	0	0	1	0	1	1	3	2
CO3	2	3	2	2	2	1	0	0	2	1	1	2	2	2
CO4	2	1	2	1	2	2	0	0	1	0	2	1	2	2
CO5	3	2	1	0	0	2	0	0	1	0	0	1	2	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	CE582	**Title of the Course**	Clay Mineralogy and Expansive Soil	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	• Familiarize Students with Nature of Soils and Soil Structure. • Equip student with concepts of Swelling and methods of determination. • Understand foundation practices in expansive soils. • Familiarize different materials and techniques for stabilization. • Understand procedure to improve shear strength of expansive soils.						

Course Outcomes	
CO1	The students have the ability to understand to identify and classify soil deposits.
CO2	The students have the ability to identify the different structure of soil minerals.
CO3	The students have an ability to find out clay water relationship.
CO4	The students will understand the nature of expansive soil.
CO5	The students will be able to understand the mineralogy of the expansive soil.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction	Origin and occurrence, Weathering and soil formation, clay minerals, composition, classification and nomenclature, non-clay and organic constituents, isomorphous substitution.	08	1
2	Structure of Clay Mineral	Cation exchange capacity, structure of clay mineral, Kaolinite, Illite and montmorillonite groups, identification by Xray diffraction, electron microscope, chemical, DTA methods.	08	2
3	Clay Water Relationships	Structure of soils effect of cations, Thixotropy, Electrical effects, Electro osmosis and electrophoresis, streaming potentials. Effects of clay minerals on engg. Properties of soils, introduction to rheological properties of clay soils.	08	3
4	Expansive Soil	Classification of expansive soils, free swells index property tests, swelling potential, measurement and prediction.	08	4
5	Mineralogy of Expansive Soil	Mineralogy aspect of swelling soils, measurement of swelling and swelling pressure. Theories of swelling, mechanical concepts, physicochemical and electro chemical theories swell calculation for simple systems.	08	5

Reference Books:

Foundation on expansive soils-Chen, F.H., pub. Elsevier Science Publishing.

Clay mineralogy – Grim R. E., pub. Tata McGraw-Hill

Applied clay mineralogy- Grim R. E., pub. Tata McGraw-Hill

e-Learning Source:

https://onlinecourses.nptel.ac.in/noc22_ce21/preview

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	3	1	1	1	1	0	0	2	1	0	1	1	1
CO2	2	1	1	0	1	1	0	0	1	0	1	1	1	2
CO3	3	2	1	0	1	0	0	0	1	0	0	0	2	1
CO4	2	2	2	1	1	0	0	0	2	1	0	1	1	1
CO5	2	2	1	1	1	0	0	0	1	1	0	1	1	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	CE583	**Title of the Course**	Ground Improvement and Geosynthetics	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	• To summarize the engineering properties of soil and problems associated with weak deposit. • To familiarize with the need for ground improvements. • To define the concept of soil stabilization. • To recall soil reinforcement techniques and geo-synthetics.						

Course Outcomes	
CO1	To understand the engineering properties of soil and problems associated with weak deposit.
CO2	The students are able to understand the various soil stabilization techniques.
CO3	To reason the need for the implementation of ground improvement techniques.
CO4	Student are able to understand the importance of grouting.
CO5	Student are able to be utilize soil reinforcement techniques and geo-synthetics.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction	Engineering properties of soft–weak and compressible deposits – problems associated with weak deposit – Requirements of ground improvements – introduction to engineering ground modification, need, objectives and outcomes.	08	CO1
2	Soil Stabilization and Methods	Science of soil stabilization – Mechanical modification –Hydraulic modification – Dewatering systems – Chemical modification –Modification by admixtures like lime, Cement, Bitumen etc. – Grouting – Deep jet mixing methods.	08	CO2
3	Ground Improvement Techniques	Recent Ground improvement techniques - stabilization using industrial waste – modification by inclusion and confinement – soil nailing – stone column – compaction piles – dynamic compaction – prefabricated vertical drains – preloading – electro-osmosis – soil freezing vacuum consolidation – deep explosion – dry powdered polymers – enzymes. Case Study on Stabilization of Locally available soil	08	CO3
4	Grouting	Grouting: Permeation grouting, compaction grouting, jet grouting, different varieties of grout materials, grouting under difficult conditions.	08	CO4
5	Geosynthetics and Reinforced Soil Structures	Types and functions; Materials and manufacturing processes; Testing and evaluations; Principles of soil reinforcement; Design and construction of geosynthetic reinforced soil retaining structures - walls and slopes; Codal provisions; Bearing capacity improvement; embankments on soft soils; Indian experiences	08	CO5

Reference Books:
Hausmann, M. R., Engineering Principles of Ground Modification, McGraw – Hill International Editions, 1990.
Saran, S., 2006. Reinforced soil and its Engineering Applications. I.K. International Pvt. Ltd
Rao, G. V. and Raju, S., 1990. Engineering with Geosynthetics. Tata McGraw-Hill Publishing Company Ltd., New Delhi
e-Learning Source:
https://archive.nptel.ac.in/courses/105/105/105105210/
https://archive.nptel.ac.in/courses/105/101/105101143/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	0	3	0	1	0	0	0	0	1	1	3	2
CO2	3	3	1	3	0	1	0	0	0	0	2	1	1	2
CO3	3	3	1	3	2	1	0	0	1	0	2	1	3	2
CO4	3	3	1	3	0	1	0	0	0	0	2	1	1	2
CO5	3	3	2	3	1	1	0	0	1	0	2	1	3	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	CE584	**Title of the Course**	Applied Geology	L	T	P	C
Year	I	**Semester**	II	3	1	0	4
Pre-Requisite	Nil	**Co-requisite**	Nil				
Course Objectives	Awareness about earth resources and processes to be considered in various facets of civil engineering.						

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Course Outcomes	
CO1	The student would comprehend better the earth resources used as building materials.
CO2	The students have the ability to learn about hydrological parameters.
CO3	The students have an ability to learn about rock and their minerals.
CO4	The course would help the student to understand of the factors that determine the stability of earth's surface.
CO5	The students will be able to learn about surface of earth as the fundamental foundation structure and the natural phenomena that influence its stability.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction	Relevance of geology in Civil Engineering. Subdivisions of Geology. Interior of the earth. Weathering, its engineering significance and laboratory tests used in civil engineering. Soil profile	08	1
2	Subsurface water Construction	Hydrogeology-occurrence of groundwater, Types of aquifers and their properties. Engineering significance of subsurface water in construction. Methods to control of subsurface water, Minerals- Properties that affect the strength of minerals.	08	2
3	Rock and Minerals	Physical properties and chemical composition of common rock forming minerals Earth quakes- in relation to internal structure of earth and plate tectonics Types of rocks. Brief account of selected rocks. Rock features that influence the strength of rocks as construction material.	08	3
4	Geological Factors of Rocks	Engineering properties of rocks. Attitude of geological structures- strike and dip. Deformation structures and their engineering significance. Geological factors considered in the construction of engineering structures.	08	4
5	Natural Hazard	Introduction to natural hazards and their management. Coastal Processes and protection strategies. Soil erosion and conservation measures.	08	5

Reference Books:

Duggal, S.K., Rawal, N. and Pandey, H.K., 2014. Engineering Geology, McGraw Hill Education, New Delhi.

Garg, S.K., 2012. Introduction to Physical and Engineering Geology, Khanna Publishers, New Delhi.

Gokhale, K.V.G.K., 2010. Principles of Engineering Geology, BS Publications, Hyderabad 4. Kanithi, V., 2012. Engineering Geology, Universities Press (India) Ltd., Hyderabad

e-Learning Source:

https://nptel.ac.in/courses/105105106

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1	1	0	2	2	0	0	1	0	0	1	2	3
CO2	3	2	1	0	2	1	0	0	1	0	1	1	3	2
CO3	2	3	2	2	2	1	0	0	1	1	1	2	2	2
CO4	2	1	2	1	2	2	0	0	1	1	2	1	2	2
CO5	3	2	1	0	0	2	0	0	1	0	0	1	2	3

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	CE585	**Title of the Course**	Geo-Environmental Engineering	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	To understand various sources of contamination of ground and to characterize contaminated ground and to find extent of contamination and to get familiarize with various remediation methods.						

Course Outcomes	
CO1	Learner should be able to identify the sources of soil contamination and its impact on geo-environment.
CO2	Learner should be able to familiarize with the retention and flow behaviour of contaminants in soil.
CO3	Leaner should be able to realize the significance of sampling techniques in geo-environmental characterization.
CO4	Leaner should be able to understand the state-of-the-art methodologies for soil decontamination and containment.
CO5	Leaner should be able to identify the origin, nature, and extent of contamination in field.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Sources and Site Characterization	Scope of Geoenvironmental Engineering, Various Sources of Contaminations, Need for contaminated site characterization; and Characterization methods.	08	CO1
2	Solid and Hazardous Waste Management	Classification of waste, Characterization of solid wastes, Environmental Concerns with waste, waste management strategies.	08	CO2
3	Contaminant Transport	Transport process, Mass-transfer process, Modeling, Bioremediation, and Phytoremediation.	08	CO3
4	Remediation Techniques	Objectives of site remediation, various active and passive methods, remediation of NAPL sites, Emerging Remediation Technologies.	08	CO4
5	Landfills	Types of landfills, Site Selection, Waste Containment Liners, Leachate collection system, Cover system, Gas collection system.	08	CO5

Reference Books:

Phillip B. Bedient, Refai, H. S. & Newell C. J. - Ground Water Contamination - Prentice Hall Publications, 4th Edition, 2008.

Sharma, H. D. and Reddy, K. R. - Geoenvironmental Engineering, John Wiley & Sons 2004.

Rowe, R. K. - Geotechnical & Geoenvironmental Engineering Handbook, Kluwer Academic, 2001.

Reddi, L. N. and Inyang, H. I. - Geoenvironmental Engineering Principles and Applications, Marcel. Dekker, Inc., New York 2000.

e-Learning Source:

https://nptel.ac.in/courses/105102160

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	0	2	0	0	1	0	0	0	0	1	3	2
CO2	2	3	0	2	0	0	2	0	0	0	0	0	3	2
CO3	3	2	0	2	0	0	1	0	0	0	1	1	3	2
CO4	3	3	0	2	0	0	2	0	0	0	0	0	3	2
CO5	3	3	0	2	0	0	1	0	0	0	0	1	3	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	CE586	**Title of the Course**	Land Contamination and Remediation	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	3	1	0	4
Pre-Requisite	Nil	**Co-requisite**	Nil				
Course Objectives	Awareness about land contamination and their remediation to be considered in various facets of civil engineering.						

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Course Outcomes	
CO1	The students have the ability to learn about contaminated land and associated problems.
CO2	The students have the ability to learn about risk management.
CO3	The students have an ability to learn about site investigation of contaminated sites.
CO4	The students will be able to understand the various remedial action contaminated sites.
CO5	The students will be able to develop design solution for contaminated sites.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction	Contaminated land and associated problems and their justification	08	1
2	Risk Management	Risk management: Scope, risk assessment, evaluation, mitigation.	08	2
3	Site Investigation	Scope & objectives, investigation techniques, sampling, analysis, in situ testing, Legal, health and safety aspects, quality assurance and control.	08	3
4	Redemption measures	Remedial actions classification and options; Civil Engineering based methods and process-based methods	08	4
5	Design and Planning	Remedy selection criteria and procedures, development of remedial strategies, treatability studies. Design and implementation of remedial measures, planning & design specification, Remediation project implementation, documents and case studies reporting.	08	5

Reference Books:

Ground Contamination: Pollutant Management and Remediation, R.N. Yong and H.R. Thomas, Pub. Thomas Telford, UK

Soil Vadose Zone and Ground Water Contamination Assessment, Prevention and Remediation, J. R. Boulding and J.S. Ginn, Pub. Lewis Publications, USA

Soil Pollution, Origin Monitoring & Remediation, Ibrahim A. Mirsal, Pub. Springer

e-Learning Source:

https://onlinecourses.nptel.ac.in/noc21_ce36/preview

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1	1	0	2	2	0	0	1	0	0	1	2	3
CO2	3	2	1	0	2	1	0	0	1	0	1	1	3	2
CO3	2	3	2	2	2	1	0	0	1	1	1	2	2	2
CO4	2	1	2	1	2	2	0	0	1	1	2	1	2	2
CO5	3	2	1	0	0	2	0	0	1	0	0	1	2	3

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	CE587	**Title of the Course**	Ground Water Hydrology	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	To understand the basics of groundwater hydrology, it's hydrologic and engineering aspects, and the mechanics involved in the study of flow of groundwater. Modeling of ground water flow through aquifers.						

Course Outcomes	
CO1	Students will learn basic concept of groundwater hydrologic cycle.
CO2	Students will learn about groundwater flow.
CO3	Students will learn about basic principle of modeling and analysis of aquifer systems.
CO4	Students will learn about the surface methods of exploration.
CO5	Students will learn about the artificial recharge of groundwater.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Groundwater	Groundwater hydrologic cycle. Origin of groundwater, quality of groundwater, vertical distribution of groundwater-zone of aeration and zone of saturation; Geologic formations as aquifers; types of aquifers, porosity, specific yield, specific retention; Permeability, Darcy's law, storage coefficient, Transmissibility	08	1
2	Groundwater flow	Groundwater flow in one, two and three- dimensions; Groundwater flow contours and their applications; Steady groundwater flow towards a well in confined and unconfined aquifers- Dupuits' and Theism's equations	08	2
3	Modeling and Analysis of Aquifer Systems	Need, model calibration, single and multi-cell models, Inverse problems, estimation of regional aquifer problems; aquifer management; linear and non-linear programming methods.	08	3
4	Investigations	Surface methods of exploration - Electrical resistivity and seismic refraction methods. Subsurface methods; Geophysical logging and resistivity logging; hydrologic maps; groundwater balance; contamination.	08	4
5	Artificial Recharge of Groundwater	Concept of artificial recharge and recharge methods, relative merits, Saline water intrusion, Ghyben-Hergberg relation, shape of interface, control of sea water intrusion.	08	5

Reference Books:

David K. Todd - Groundwater Hydrology, John Wiley & Sons. New York, 1998

Bear, J. - Hydraulics of Groundwater, Mc Graw Hill, New York, 1979.

Raghunath, H. M. Groundwater, Wiley Eastern Ltd., 1990

e-Learning Source:

https://nptel.ac.in/courses/105103026

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2	0	0	0	0	0	0	1	1	0	2	3
CO2	2	2	3	2	0	1	0	0	0	1	1	1	2	3
CO3	2	3	3	2	0	1	0	0	0	2	0	1	3	2
CO4	2	2	2	1	0	0	0	0	2	2	2	0	2	2
CO5	3	2	2	2	0	1	0	0	3	2	3	1	2	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	CE588	**Title of the Course**	Soil Mechanics Lab	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	0	0	3	2
Pre-Requisite	------	**Co-requisite**	------				
Course Objectives	The main objective of this lab course is to make the students in better understanding of basic index and engineering properties of soil.						

Course Outcomes	
CO1	Students are able to learn the relative density of soil.
CO2	Students are able to learn the consolidation properties of soil.
CO3	Students are able to learn shear strength parameters of soil using direct shear test.
CO4	Students are able to learn shear strength parameters of soil using Triaxial Test.
CO5	Students are able to determine SPT value.
CO6	Students are able to find out grain size distribution curve using hydrometer test.
CO7	Students are able to determine CBR value of soil with mix.
CO8	Students are able to to determine dry density using heavy compaction.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Experiment-1	To determine the relative density of soil.	03	1
2	Experiment-2	To determine consolidation properties of soil.	03	2
3	Experiment-3	To determine the shear strength parameters of soil using direct shear test	03	3
4	Experiment-4	To determine the shear strength parameters of soil using Triaxial Test	03	4
5	Experiment-5	To determine SPT value.	03	5
6	Experiment-6	To find out grain size distribution curve using hydrometer test.	03	6
7	Experiment-7	To determine CBR value of soil with mix.	03	7
8	Experiment-8	To determine dry density using heavy compaction.	03	8

Reference Books:

Alam Singh and Chowdary, G.R., "Soil Engineering in Theory and Practice (Vol.2) Geotechnical Testing and Instrumentation, CBS Publishers and Distributors, New Delhi, 2006

I.S. Code of Practice (2720): Relevant Parts, as amended from time to time

Bowles, J.E., Engineering properties of soils and their measurements, McGraw Hill, 1992.

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	0	0	3	0	0	0	0	0	0	0	0	1	3
CO2	2	0	0	2	0	0	0	0	0	0	0	0	1	3
CO3	2	0	0	2	0	0	0	0	0	0	0	0	2	2
CO4	2	0	0	3	0	0	0	0	0	0	0	0	1	3
CO5	2	0	0	3	0	0	0	0	0	0	0	0	2	2
CO6	2	0	0	1	0	0	0	0	0	0	0	0	1	2
CO7	2	0	0	2	0	0	0	0	0	0	0	0	1	2
CO8	3	0	0	3	0	0	0	0	0	0	0	0	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2020-2021							
Course Code	CE552	**Title of the Course**	Research Methodology	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	To develop critical thinking and understand the concept of gap identification for research. To identify appropriate research methods for a specific research problem and prepare professional research report						

Course Outcomes	
CO1	Develop the student's understanding of research methods and applying those methodology to solve complex research problems.
CO2	Develop student's understanding of sampling techniques for research.
CO3	Develop student's understanding of different data collection methods and their suitability.
CO4	Students will gain understanding of analyzing the quantitative data.
CO5	Students will gain understanding of analyzing the qualitative data and will learn how to write a professional research report.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to Research and Problem Definition	Meaning, Objective and importance of research, Types of research, research process, Challenges in research, Philosophical worldviews in research.	08	CO1
2	Research Design	Research design, Methods of research design, Selection of a Research Design research process and steps involved, Literature Survey, Bibliometric analysis.	08	CO2
3	Data Collection	Sample Design, Sampling Methods, sampling errors, Classification of Data, Measurement and Scaling, Methods of Data Collection, data preparation.	08	CO3
4	Data Analysis and interpretation	Data analysis, Statistical techniques and choosing an appropriate statistical technique, Hypothesis, Hypothesis testing, Data processing software (e.g. SPSS etc.), statistical inference, Interpretation of results.	08	CO4
5	Technical Writing and Reporting of Research	Types of research report: Dissertation and Thesis, research paper, review article, short communication, conference presentation etc., Referencing and referencing styles, Mechanics of writing a report, Research Journals, Indexing and citation of Journals, Intellectual property, Plagiarism, Oral Presentation.	08	CO5

Reference Books:

C. R. Kothari, Gaurav Garg, Research Methodology : Methods And Techniques, New Age International Publishers; Fourth edition (1 September 2019)

Creswell, J. W., & Creswell, J. D. (2017). Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications.

Sekaran, U., & Bougie, R. (2016). Research methods for business: A skill building approach. John Wiley & Sons.

e-Learning Source:

https://onlinecourses.nptel.ac.in/noc22_ge08/preview

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	1	0	0	0	0	0	0	0	0	0	0	0
CO2	3	3	2	0	0	0	0	0	0	0	0	0	0	0
CO3	3	3	2	3	0	0	0	0	0	0	0	0	0	0
CO4	3	3	2	3	3	0	0	0	0	0	0	0	0	0
CO5	3	3	0	0	0	0	0	3	0	3	0	0	0	0

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	CE589	**Title of the Course**	Site Investigation and Foundation Design	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	• To determine the bearing capacity of shallow and deep foundations, to estimate settlements of structures subjected to external loads, leading to design of foundations resting on soils.						

Course Outcomes	
CO1	To understand the basics of soil exploration.
CO2	To learn the procedure to design shallow foundations on various ground conditions.
CO3	To learn about various methods to calculate the bearing pressure.
CO4	To learn the procedure to design deep foundations on various ground conditions.
CO5	To understand about special topics of foundation engineering.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Soil Exploration	Site investigation & exploration, location, depth of bore holes and bore log chart.	08	CO1
2	Shallow Foundations: Bearing Capacity	Shallow foundations, Bearing capacity theories, settlement. I.S. Code on structural safety of foundations Allowable total and differential settlements.	08	CO2
3	Settlement	Bearing Pressure using SPT, CPT, Dilatometer and Pressure meter; Settlement of foundations on Sands, Schmertmann and Burland & Busbridge methods; Structure Tolerance to Settlement and Differential Settlements, Rotation of Tall Structures. Load Tests: Indian standard specification on Load Tests. Contact Pressure distribution.	08	CO3
4	Deep Foundations: Pile Foundation	Pile Foundations: Type of Piles, Allowable load on pile load test, Dynamic Formula, Static Formula. Pile Groups in sand clays-settlement and bearing capacity IS Codes of piles. Behavior of pile under lateral loading-Winkler's assumptions, Micropyles	08	CO4
5	Special Topics of Foundation Engineering	Sheeting and Bracing System: Earth pressure determination, and Design method. Design of Anchored Bulk Heads. Under Pinning of Foundations. Hollow box foundation or Buoyancy foundations, Legal Aspects of Foundation Engineering	08	CO5

Reference Books:

Foundation Design and Construction – Tomilson, pub. Longman Group, UK

Foundation Analysis and Design - J. E. Bowles, pub. Tata McGraw-Hill.

Design Aid in Soil Mechanics and Foundation Engineering- Kaniraj, pub. McGraw-Hill Publications.

Design of Foundation System –Kurian, pub. Alpha Science International.

e-Learning Source:

https://onlinecourses.nptel.ac.in/noc22_ce32/preview

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	1	3	2	0	0	0	1	0	1	1	1
CO2	3	1	1	0	2	1	0	0	1	0	2	0	2	0
CO3	2	2	0	2	1	1	0	1	0	1	0	0	2	1
CO4	1	2	3	1	1	1	0	0	0	0	1	1	1	2
CO5	3	1	0	0	2	2	0	0	1	1	0	0	1	0

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	CE590	**Title of the Course**	Rock Engineering	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	3	1	0	4
Pre-Requisite	Nil	**Co-requisite**	Nil				
Course Objectives	To determine properties and behavior of various types of rock under different loading conditions for underground and open excavations.						

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Course Outcomes	
CO1	The students have the ability to engineering classification of rocks.
CO2	The students have the ability to laboratory and in-situ testing of rocks.
CO3	The students have an ability to find strength, modulus and stresses-strain responses of rocks.
CO4	The students will be able to understand stability of rock slopes and foundations on rocks.
CO5	The students will be able to tell about the underground and open excavations.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Engineering Classification of Rocks	Classification of intact rocks, Rock mass classifications, Rock Quality Designation (RQD), Rock Structure Rating (RSR), Rock Mass Rating (RMR), Norwegian Geotechnical Classification (Q-system), Strength and modulus from classifications, Classification based on strength & modulus and strength and fracture strain, Geoengineering classification.	08	1
2	Laboratory and In-Situ Testing of Rocks	Physical properties, Compressive strength, Tensile strength, Direct shear test, Triaxial shear test, Slake durability test, Schmidt rebound hardness test, Sound velocity test, In-Situ Tests: Seismic methods, Electrical resistivity method, In situ stresses, Plate loading test, Goodman jack test, Plate jacking test, In-situ shear test, Field permeability test.	08	2
3	Strength, Modulus and Stresses-Strain Responses of Rocks	Factors influencing rock response, Strength criteria for isotropic intact rocks, Modulus of intact rocks, effect of confining pressure, Uniaxial Compressive strength, Strength criteria for intact rocks, Strength due to induced anisotropy in rocks. Stress Strain Models: Constitutive relationships, Elastic, Elasto-plastic, Visco-elastic, Elasto-viscoplastic stress-strain models.	08	3
4	Stability of Rock Slopes and Foundations on Rocks	Rock slopes, Modes of failure, Rotational failure, Plane failure, Design charts, Wedge method of analysis, Buckling failure, Toppling failure, Improvement of slope stability and protection. Foundations on Rock: Introduction, Estimation of bearing capacity, Stress distribution, Sliding stability of dam foundations, strengthening measures, Settlements in rocks, Bearing capacity of pile/pier in rock, Remedial measures, Foundations located on edge of jointed slope.	08	4
5	Underground and Open Excavations	Blasting operational planning, Explosive products, Blast Design, Underground blast design, Controlled blasting techniques, blasting damage and control, Safe practice with explosives and shots.	08	5

Reference Books:
Goodman – Introduction to Rock mechanics, Willey International (1980).
Ramamurthy, T. - Engineering in Rocks for slopes, foundations and tunnels, Prenice Hall of India. (2007).
Jaeger, J. C. and Cook, N. G. W. – Fundamentals of Rock Mechanics, Chapman and Hall, London. (1979).
Hoek, E. and Brown, E. T. - Underground Excavation in Rock, Institution of Mining and Metallurgy, 1982.
e-Learning Source:
https://archive.nptel.ac.in/courses/105/107/105107208/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1	1	0	2	2	0	0	1	0	0	1	2	3
CO2	3	2	1	0	2	1	0	0	1	0	1	1	3	2
CO3	2	3	2	2	2	1	0	0	1	1	1	2	2	2
CO4	2	1	2	1	2	2	0	0	1	1	2	1	2	2
CO5	3	2	1	0	0	2	0	0	1	0	0	1	2	3

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2019-20							
Course Code	CE572	**Title of the Course**	Research Paper Presentation and Discussion /Seminar	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	0	0	3	2
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	• To understand organization of topic for presentation and research. • To learn the skill set required to perform research.						

Course Outcomes	
CO1	Skill to search on any topic to extract the inference.
CO2	Ability to organize – deliver presentation and report on any topic.

Unit No.	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Seminar shall be delivered preferably on the topic of dissertation or at least the area of dissertation. The concepts must be clearly understood and presented by the student. Prior to presentation, he/she shall carry out the detailed literature survey from Standard References such as International Journals and Periodicals, recently published reference Books etc. All modern methods of presentation should be used by the student. A hard copy of the report (25 to 30 pages) should be submitted to the Department before delivering the seminar. A PDF copy of the report in soft form must be submitted to the supervisor along with other details if any. Supervisor should guide concern student 2hrs /week/student for seminar.	03	CO1 and CO2

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	0	0	0	3	3	1	2	1	3	3	0	3	3	3
CO2	0	0	0	0	3	1	2	1	3	3	0	3	3	3

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	CE591	**Title of the Course**	Advanced Geotechnical Engineering Lab	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	0	0	3	2
Pre-Requisite	NIL	**Co-requisite**	-				
Course Objectives	Students are expected to hand on practice on different finite element software used in various geotechnical engineering problem.						

Course Outcomes	
CO1	Students are able to learn to determine determination of RQD of given rock sample.
CO2	Students are able to determine tensile strength of rock by Point Load Test and Brazilian Test.
CO3	Students are able to determine the bearing Capacity and settlement of shallow foundations using software.
CO4	Students are able to determine the modelling and analysis of static and dynamic soil structure interaction problems using software.
CO5	Students are able to determine the engineering property of soil using MATLAB.
CO6	Students are able to determine numerical modelling and static and dynamic analysis of slope stability problems.
CO7	Students are able to study stability of soil nailing using software.
CO8	Students are able to study the elastic and plastic analysis of different structures using OPTUM G2.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Experiment -1	To determine RQD of given rock sample.	03	1
2	Experiment-2	To determine tensile strength of rock by Point Load Test and Brazilian Test.	03	2
3	Experiment-3	To determine the bearing Capacity and settlement of shallow foundations using software.	03	3
4	Experiment-4	To study the modelling and analysis of static and dynamic soil structure interaction problems using software.	03	4
5	Experiment-5	To determine the engineering property of soil using software.	03	5
6	Experiment-6	To determine numerical modelling and static and dynamic analysis of slope stability problems.	03	6
7	Experiment-7	To study stability of soil nailing using software.	03	7
8	Experiment-8	To study the elastic and plastic analysis of different structures using software.	03	8

Reference Books:

Lab manual provided by the department

Alam Singh and Chowdary, G.R., "Soil Engineering in Theory and Practice (Vol.2) Geotechnical Testing and Instrumentation, CBS Publishers and Distributors, New Delhi, 2006.

I.S. Code of Practice (2720): Relevant Parts, as amended from time to time.

Bowles, J.E., Engineering properties of soils and their measurements, McGraw Hill, 1992.

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO / CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	0	0	2	0	0	0	0	0	0	0	0	2	3
CO2	3	0	0	2	0	0	0	0	0	0	0	0	2	3
CO3	2	0	0	3	0	0	0	0	0	0	0	0	2	3
CO4	2	0	0	2	0	0	0	0	0	0	0	0	2	3
CO5	3	0	0	3	0	0	0	0	0	0	0	0	2	3

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation