M.Tech., Geotechnical Engineering (MCGT)

(Effective from the Academic year 2024-25)

Program Outcome of this course

Sl. No.	Description	POs
1	Ability to apply knowledge of mathematics; science and engineering while analysis and design of geotechnical structure ant its components	1
2	Assess the properties of soil under critical conditions	2
3	Plan the geotechnical designs for meeting socio-economical and environmental needs	3
4	Design and manage the geotechnical structures for optimal utilization	4
5	Manage the stability of ground and ground properties in the changing climate scenario	5
6	Analyze ground extremes and adopt suitable management practices to minimize impacts	6
7	Work and lead in multi disciplinary environment and demonstrate professional and social ethics	7
8	Engage the engineers in critical thinking and pursue lifelong learning for professional advancement	8

Semester – II

Geo-technology and Advanced Soil Testing			
Course Code	MCGT201	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Course objectives: • To explore the scientific principles used to describe the major engineering properties of soil, and the engineering testing methods used to quantify these properties • To explain role of water in soil behavior with change in soil stresses, permeability and quantity of seepage including flow net are estimated • To determine shear parameters and consolidation characteristics in soil • To understand field methods of soil testing and methods			
MODULE-1			
Factors influencing nature and formation of soils. Soils as a multiphase material, Complexity of soil nature, Typical soil deposits with special reference to Indian soils. Basic engineering properties of different soils and their uses. Study of rocks: Formation, basic types of rocks, igneous, sedimentary, metamorphic rocks and their classification. Geological structures: Folds, faults and joints, their classification, criteria for the identification of faults and other discontinuities.			
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving,		

	laboratory demonstration.
MODULE-2	
Soil Structure –Types of bonds, Important clay minerals, atomic structure and symbolic representation. Base exchange capacity, Guoy chapman diffuse double layer theory, clay structure measurement – X- ray diffraction, SEM studies, DTA, Pore size analysis.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, laboratory demonstration, Industrial visits.
MODULE-3	
Tests for Index properties of soils – Water content, Specific gravity, relative density, grain size analysis (both sieve and hydrometer analysis), Atterberg's limits, Relative merits and Demerits of different methods. Numerical problems.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
MODULE-4	
Tests for engineering properties of soils – Compaction, Consolidation characteristics, Permeability, Shear tests including pore pressure measurements (UU, CU, CD tests). Numerical problems. Comments and recommendations on the results.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, lab demonstration.
MODULE 5	
Field tests for soils: Field Vane Shear test. Plate load test, SPT, SCPT, DCPT, Merits and demerits, Applications & their uses. Numerical problems. Pile load tests, Tests on Piles for Tension loads and Compression loads. Earth pressure measurements (Menard pressure meter& dilatometer)	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, field visits, NPTEL ppts.

PRACTICAL COMPONENT OF IPCC (May cover all / major modules)

Sl.No.	Experiments
1	Field identification of soils based on soil deposits and reports on the Residual soilsand transported soils.
2	Determination of water content in the field by rapid moisture method.
3	Determination of soil structures of clays by x-Ray diffraction method
4	Determination of soil structures of clays by SEM method
5	Comparison of determining the percentage of silt and clay by pipette method and hydrometer method.
6	6Determining Relative densities of sand deposits and Relative compaction of soil deposits
7	Quality control check of compacted fills using Proctor needle method
8	Determining the volumetric ratios of the compacted fill
9	Comparison of different shear parameters from the different shear tests.
10	Model pile load tests under compression loading and tension loading
11	Demonstration of Menard pressure meter.
12	Demonstration of Standard Penetration test, SCPT, DCPT, Plate Load tests.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements

and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

1. Two Tests each of 25 Marks
2. Two assignments each of 25 Marks/One Skill Development Activity of 50 marks
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to 30 marks.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The 15 marks are for conducting the experiment and preparation of the laboratory record, the other 05 marks shall be for the test conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks.

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for 20 marks.

SEE for IPCC

Theory SEE will be conducted by the University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

• The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of CV 20.06.2023 10.08.2023 maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included. The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

• SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course (CIE+SEE)

Suggested Learning Resources: Text Books:

1. An Introduction to the Mechanics of Soils and Foundation - through critical state soil mechanics- Atkinson J. H. - McGraw- Hill Co. (1993)

2. Soil Behavior and Critical State Soil Mechanics Wood, D.M (1991)- cambridge university press

3. Soil Mechanics SI version- Lambe, T. W. and Whitman, R. V, John Wiley &Sons. (4011) 4. Soil

Mechanics and Foundations, MuniramBudhu(4007), John Wiley & Sons, Inc.

Reference Books:

1. Geotechnical Engineering- Donold P Coduto Phi Learning Private Limited, New Delhi
2. Soil Mechanics and Foundation Engg.- Muni Budhu (4010),
3 rd Edition, John Wiely& Sons 3. Soil Mechanics- J A Knappett and R F Craig Eighth Edition (4012), Spon Press Taylor & Francis

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105101160
- http://eagri.org/eagri50/SSAC122/lec17.pdf
- https://www.youtube.com/watch?v=dkcs9JtB2Eo

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Analyze the soil stresses, permeability and seepage for the existing field conditions	L1, L3, L4
CO2	To understand the compressibility behavior of soil and consolidation settlement along with time rate of settlement	L3, L4

CO3	To find a suitable method for determining the shear parameters and identifying the suitable testing methods for the field constraints	L4, L5

Mapping of COS and POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	x	x		x	x		
CO2	x				x		x
CO3	x		x	x	x		x

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Conducting field visits for observing plate load tests, SCPT, SPT and pile load tests

Preparing model tests for pile testing

Design of Shallow Foundations			
Course Code	MCGT202	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	26 Hr. Theory + 26 Hr. SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understanding the capacity of the soil under different field conditions
- Design of shallow foundations under different loading conditions and different environment
- Design of footings for uniform settlement of all shallow foundations.
- To design Foundations on landfills and filled up soils

Module-1

Bearing Capacity of Foundations: Introduction, Types of shallow foundations, General requirements of foundations, Modes of shear failure, bearing capacity equations (Terzaghi's, Meyerhof's, Brinch Hansen's and IS code method), Footings with eccentric loadings, Effect of water table on bearing capacity. Bearing capacity from SPT, SCPT, DCPT and Field plate load tests. Evaluation from in-situ tests codal recommendations. Numerical Problems.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving,

Module-2

Bearing Capacity for footings on homogeneous and layered soils, slopes, bearing capacity of foundations with uplift or tension forces, bearing capacity of rock, bearing capacity based on Building codes (Presumptive pressure), Safety factors in Foundation Design, Numerical Problems.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving,
Module-3	
Settlement analysis: Immediate settlement, Consolidation settlement and Secondary consolidation settlements, With codal provisions. Numerical problems. Contact pressure under footings – Contact pressure under rigid rectangular footing, strip foundation, rigid circular footing, Principles of footing design, Design of non – rigid combined footings.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-4	
Foundations on sanitary landfill site, recent refuge fills, residual soils, permafrost and adjoining to the river bed. Proportionating of shallow footings, Introduction to special foundations, Foundation design in relation to ground movements.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through case studies and problem solving,
Module-5	
Design of Raft foundations- types of rafts, Bearing capacity of mat foundations, Mat settlements, Modulus of subgrade reactions for matts and subgrades, Numerical problems. Allowable soil pressures for rafts in cohesionless and cohesive soils, Design of raft by rigid beam method and Winkler method, Solution based on elastic half space and based on elastic theory.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through case studies. NPTEL

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marksto attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each

Suggested Learning Resources:

Text Books:

1. Foundation Engineering, Verghese P C. (4011)– PHI, India
2. Foundation Engineering, Teng (1992) - PHI, India
3. Foundation Engineering, Bajra MDas.(4012), Cengage Learning India
4. Foundation Analysis and Design, J E Bowles(4012), McGraw Hill, Inc.

Reference Books:

1. Foundation Engineering, Peck hanson & Thronburg(1974). John Wiley & Sons,.
2. Analysis and design of Subsructures- Swami Saran (4009), Oxford & IBH
3. Foundation Engineering Naryana S Naik(4012), Dhanphat Rai publishers, New Delhi
4. Geotechnical Engg.- P. Purushothamraj (4010), Tata McGraw Hill

Web links and Video Lectures (e-Resources):

- **https://onlinecourses.nptel.ac.in/noc21_ce39/preview**
- **https://archive.nptel.ac.in/courses/105/105/105105176/**
- **https://www.youtube.com/watch?v=2AbH0FJBWNg**

Skill Development Activities Suggested

- Nptel courses
- Lab demonstration
- Models making
- Identifying the soil properties in the field

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Analyse the bearing capacity of the soil for shallow foundations	L2,L3,L4,L5
CO2	Design aspects of Raft foundations for achieving uniform settlement for special structures like watertanks	L1,L2,L3,L6
CO3	Structural design of shallow foundations in all conditions like land-fills, pavements etc in varying conditions including seismic areas	L1, L2,L3,L6
CO4	Proper communication with structural and other engineers	L2,L4,L5,L6

Mapping of COS and POs

	PO1	PO4	PO5	PO6	PO7	PO8
CO1	-	×	×	×	-	-
CO2	×	×	×	×	×	×
CO3	×	×	-	×	×	×
CO4	×	×	-	-	-	-

Design of Deep Foundations			
Course Code	MCGT203	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	25 hours theory +26 hours SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the need of deep foundations and applications
- Know the design of deep foundation.
- Type of deep foundations will be provided for different structures.
- Understand the need of special foundations.

Module-1

Single pile - Static capacity and lateral loads: Introduction, Timber, Concrete, Steel piles, Corrosion of steel piles, Soil properties for static pile capacity, Ultimate static pile point capacity, Skin resistance, Static load capacity using load transfer, load test data, Tension piles, Piles for resisting uplift, laterally loaded piles. Buckling of fully and partially embedded piles and poles, Numerical problems.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving,

Module-2

Single pile – Dynamic analysis and load tests: Dynamic analysis, Pile driving, Rational pile formulae, other dynamic pile driving formulae and general considerations, Reliability of dynamic pile driving formulae. The wave equation, pile load tests, pile driving stresses, general comments on pile driving, Numerical problems.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving,
Module-3	
Pile foundations – Group, Single pile v/s Pile group, Pile group considerations, efficiency of pile groups, stresses on underlying strata from piles, settlements of pile groups, pile caps, Batter piles, Negative skin friction, Numerical problems.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-4	
Well Foundation:Design and construction. Bearing capacity, settlement and lateral resistance. Tilts and shifts, Numerical problems. Drilled Shaft: Construction procedures, Design Considerations, Load Carrying Capacity and settlement analysis, Numerical problems.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through case studies and problem solving,
Module-5	
Special Topics of Foundation Engineering Foundations on Collapsible Soils: Origin and occurrence, Identification, Sampling and Testing, Preventive and Remedial measures. Foundations on Expansive Soils: The nature, origin and occurrence, Identifying, testing and evaluating expansive soils, typical structural distress patterns and Preventive design & construction measures, Numerical Problems.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through case studies. NPTEL

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books:

1. Analysis and design of Substructures (4009), Swami Saran, Oxford & IBH PublicationsPvt. Ltd.
2. Foundation design in practices (4010)- Kaurna Moy Ghosh. PHI
3. Foundation engineering (4012)- J E Bowles, McGraw Hill

Reference Books:

1. Pile Foundation Analysis and Design H.G. Poulos, and E.H.Davis, John Wiley and Sons, New York.
2. Design of Foundation Systems (1992) N.P. Kurien: Principles & Practices, Narosa, New Delhi.
3. Foundation Engineering Hand Book (1990), H. F. Winterkorn and H Y Fang Galgotia Booksource

Web links and Video Lectures (e-Resources):

- **https://www.youtube.com/watch?v=SZefeLiaiIE**
- **https://www.youtube.com/watch?v=4U8NuA10Gzs**
- **https://www.youtube.com/watch?v=NqwbkIVqLKY**
- **https://nptel.ac.in/courses/105105039**

Skill Development Activities Suggested

- Making field visits to pile driving site
- Observing different types of piles
- Making models of piles and pile load tests
- NPTEL videos

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	To analyze and adopt design skills of vertical and batter piles for various types of loading and soil conditions.	L2,L3,L4,L5
CO2	To design the sheet piles and under reamed piles in expansive soils.	L1,L2,L3,L6
CO3	To design the well foundations (caissons).	L1,L2,L3,L6
CO4	To design special types of foundations in order to provide stability to the structures.	L2,L4,L5,L6

Mapping of COS and Pos:

	PO1	PO4	PO5	PO6	PO7	PO8
CO1	-	×	×	×	-	-
CO2	×	×	×	×	×	×
CO3	×	×	-	×	×	×
CO4	×	×	-	-	-	-

Earth Pressure and Earth Retaining Structures			
Course Code	**MCGT204**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40 hours	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

- To study the static earth pressure for retaining walls, etc.
- To understand the design parameters of retaining walls and design methods

Module-1	
Earth Pressure: Introduction, Rankine's theory of total active and passive earth pressure and its point of application, Coulomb's wedge theory of total active and passive earth pressure, Culmann's and Rebhann's graphical methods for determination of active and passive earth pressures, earth pressure calculations for line load and/or uniform strip load acting on the ground surface.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-2	
Retaining wals: Types of retaining walls, Failure of retaining walls by sliding, overturning and bearing. Stability and principles of the design of retaining walls – Gravity retaining walls, cantilever retaining walls, counterfort retaining walls, modes of failure of retaining walls, drainage from the	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-3	

Bulk heads: Cantilever sheet pile walls - Types of sheet pile walls, free cantilever sheet pile, cantilever sheet pile in cohesion less soils and in clay. Bulk heads: Anchored cantilever sheet pile walls - Anchored sheet pile with free earth support in cohesionless and cohesive soil. Bulk heads with fixed earth support method.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-4	
Braced cuts: Introduction, lateral earth pressure on sheeting, different types of sheeting and bracing systems, design of various components of bracings.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-5	
Coffer dams and Cellular coffer dams: Introduction, types of coffer dams, design of cellular coffer dams on rock by Tennes Valley Authority (TVA) method, safety against sliding, slipping, overturning, vertical shear and stability against bursting.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equalmarks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from eachmodule.
4. Each full question will have a sub-question covering all the topics under amodule.
5. The students will have to answer five full questions, selecting one full question from eachmodule

Suggested Learning Resources:

Text Books:

1. Foundation analysis and design - J E Bowles, McGraw Hill, NY
2. Soil Mechanics in Engineering Practice – Karl Terzaghi and R B Peck (1967), John Wiley and Sons, NY
3. Analysis and Design of Foundations and Retaining Structures –S Prakash(1979), Sarita Prakashana, Meerut

Reference Books:

1. Soil Mechanics and Foundation Engineering – S K Garg, Khanna Publications
2. Geotechnical Engineering – C Venkataramaiah, New Age International Publishers

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105105176
- https://www.nptelvideos.com/video.php?id=2024&c=11
- https://freevideolectures.com/course/4415/nptel-foundation-engineering/48
- https://www.slideshare.net/shita43/lecture24-114860618

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	To analyze the field problems and encountering various failures due to shear geostatic stress etc	L2, L4
CO2	To design and analyze the retaining structures for earth pressures.	L2, L4, L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**x**	**x**					**x**	**x**
CO2	**x**		**x**	**x**				**x**

Advanced Soil Mechanics			
Course Code	MCGT215A	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	25 hours + 26 hours	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To explore the scientific principles used to describe the major engineering properties of soil, and the engineering testing methods used to quantify these properties.
- To explain role of water in soil behavior with change in soil stresses, permeability and quantity of seepage including flow net are estimated.
- To determine shear parameters and stress changes in soil due to foundation loads.
- To estimate the magnitude and time-rate of settlement due to consolidation.

Module-1

Module -1

Geostatic Stresses:Effective stress principle, Geostatic stresses, Soil water hydro statics and dynamics, Numerical Problems. Lambe's compaction theory, Structural and Engineering properties of compacted soils, Laboratory compaction tests, Field compaction control related problems.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving,

Module-2

Immediate settlement – Methods of determination, Estimation of preconsolidation pressure, three-dimensional consolidation equation, pre compression of clay deposits with and without sand drains, Secondary consolidation, factors affecting.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving,
Module-3	
Shear strength parameters of cohesionless and saturated cohesive soils, Principle of effective stress, effect of rate of strain on shear parameters, Stress – Strain relationship, Pore pressure coefficients, Concept of stress path, Laboratory and Field testing their limitations.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-4	
Stability Analysis of Slope: Effective and total stress approach, shape of slip surface, sweedish method, methods of slices, location of centre of critical slip circle, Friction circle method, Tayler's stability number, Bishop's rigours analysis, stability during critical conditions.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through case studies and problem solving,
Module-5	
Elastic theories of stress distribution in soils -Bousinesq's, Westergaard's, Bermister's theories. Different conditions of loading, Isobars, Newmark's chart, Numerical problems.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through case studies. NPTEL

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for thecourse.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books:

1. An Introduction to the Mechanics of Soils and Foundation - through critical state soil mechanics- Atkinson J. H. - McGraw- Hill Co. (1993)
2. Soil Mechanics SI version- Lambe, T. W. and Whitman, R. V, John Wiley & Sons.(4011)
3. Soil Mechanics and Foundations, Muniram Budhu(4007), John Wiley & Sons, Inc.

Reference Books:

1. Geotechnical Engineering- Donold P Coduto Phi Learning Private Limited, New Delhi
2. Soil Mechanics and Foundation Eng.- Muni Budhu (4010), 3rd Edition, John Wiely & Sons
3. Soil Mechanics- J A Knappett and R F Craig Eighth Edition(4012), Spon Press Taylor & Francis

Web links and Video Lectures (e-Resources):

- **https://www.youtube.com/watch?v=FEkndgIWK24&list=PLwdnzlV3ogoVEn-ZybrekVqMj3cCa0uzj**
- **https://archive.nptel.ac.in/courses/105/103/105103207/**
- **https://ocw.mit.edu/courses/1-361-advanced-soil-mechanics-fall-2004/pages/lecture-notes/**

Skill Development Activities Suggested

- Nptel courses
- Lab demonstration
- Models making
- Identifying the soil properties in the field

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Analyse the soil stresses, permeability and seepage for the existing field conditions	L2,L3,L4,L5
CO2	To understand the compressibility behaviour of soil and consolidation settlement along with time rate of settlement	L1,L2,L3,L6
CO3	To develop suitable method for analyzing the slope stability	L1,L2,L3,L6
CO4	To understand the behaviour of soils at critical state	L2,L4,L5,L6

Mapping of COS and POs

	PO1	PO4	PO5	PO6	PO7	PO8
CO1	-	×	×	×	-	-
CO2	×	×	×	×	×	×
CO3	×	×	-	×	×	×
CO4	×	×	-	-	-	-

Ground Waterand Hydrology			
Course Code	**MCGT215B**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 hours + 26 hours	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

- To understand the behaviour of the ground water and its percolation in soils.
- Determination of ground water movement.
- Recharging of ground water.

Module-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.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-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, Formation constants, yield of an open well, interference and well tests; Unsteady flow towards a well – Non-Equilibrium equations – Theis's solution- Jacob and Chow's simplifications, Leaky aquifers

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-3	
Modelling 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.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-4	
Investigations: Surface methods of exploration - Electrical resistivity and seismic refraction methods. Subsurface methods; Geophysical logging and resistivity logging; hydrologic maps; groundwater balance; contamination	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-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.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for thecourse.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books:

1. Foundations of Theoretical Soil Mechanics, Harr, M.E (1966) McGraw Hill,
2. Foundation Engineering Handbook, Winterkorn, H.F., and Fang, H.Y(4000) Galgotia, Booksource, 4000
3. Theoretical Soil Mechanics- Karl Terzaghi (1943), John Wiley & Sons.
4. Soil Mechanics and Foundations, MuniramBudhu(4007), John Wiley & Sons, Inc.

Reference Books:

5. Soil Mechanics, T.W. Lambe and R.V. Whitman(1969). John Wiley &Sons,.
6. Foundations and slopes- Attikinson (1981), McGraw Hill, New Delhi
7. Seepage, Drainage and Flownets – Cedergren H R(1997).-,John Wiely& Sons.
8. The Mechanics Basic concepts and Engineering Applications- Aysen A (4002), AA Balkema Publishers, 4002

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105103026
- https://nptel.ac.in/courses/105105042
- https://archive.nptel.ac.in/courses/105/101/105101214/
- https://pubs.usgs.gov/wsp/2220/report.pdf
- https://www.britannica.com/science/groundwater

Skill Development Activities Suggested

- water quality assessment
- Field activities included
- Ground water recharge activities

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Estimate the percolation of ground water in different soils and understand seepage mechanism.	L2, L4
CO2	Estimate of the contamination in soils from the field tests.	L2, L4
CO3	Suitable design methodology for recharging of ground water.	L4, L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x				x	x		x
CO2	x	x						
CO3	x			x			x	x

Earthquake Resistant design of Foundations			
Course Code	**MCGT215C**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40 hours	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

- Focused mainly on identifying the dynamic loading induced on the foundation.
- Understand soil - foundation interaction, analysis with reference to various design parameters that including liquefaction of soil due to earthquake.

Module-1	
BASIC DESIGN PARAMETERS: Dynamic properties of soils and its evaluation, strength and deformation characteristics of soils under earthquake loading, liquefaction hazard evaluations and remedial measures, geotechnical failure of foundations during earthquake, provision of IS 1893 and IS 13940.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-2	
Design requirements – bearing capacity theory under earthquake loading – bearing capacity analysis for liquefied soil – bearing capacity analysis for cohesive and cohesionless soils - seismic settlement of foundation.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving.

Module-3	
Sesmic design of Pile foundations: Earthquake loading – inertial and kinematic loading - performance of piles during earthquake loading – theories of pile failure in liquefiable soils – failure based on bending mechanism/buckling instability – methods of analysis – force based or limit equilibrium method – p-y method – pile settlement - guidelines for designing of piles under kinematic loading due to liquefaction – seismic design of well/cassion foundations.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-4	
Sesmic design of retaining walls: Introduction – Seismic passive lateral earth pressure, behaviour of retaining wall during earthquakes, modification of Coulomb's Theory, Modified Culmann's Theory, displacement analysis, Indian standard code of practice.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-5	
Structural design of foundation: Introduction – loads acting on foundations during earthquake – fundamental failure mechanisms of foundations – essential criteria for design of foundations in liquefiable soils – structural design of foundations subjected to earthquake loading.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Assessment Details (both CIE and SEE) The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing	

marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for thecourse.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. Design of foundation in seismic areas: Principles and some applications by (4007).Bhattacharya S. (eds), Published by NICEE [National Centre for Earthquake Engineering (India)].

2. Geotechnical Earthquake Engineering (4002): Day R. W., handbook, McGraw – Hill, New York
3. Design of Pile Foundations in Liquefiable Soils (4010) Gopal Madabhushi, Jonathan Knappett and Stuart Haigh, Imperial College Press, London
4. Basic geotechnical earthquake engineering by (4008) Kamalesh Kumar, New Age International Publishers, New Delhi

Reference Books:

1. Soil dynamics (1981) Prakash, S., McGraw Hill, New York,.
2. Geotechnical Earthquake Engineering (1996), Steven L. Kramer, Prentice Hall, New Delhi,.
3. Foundation design and construction (1986), Tomilinson M.J., Longman Scientific & Technical, England,

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/107/105107204/
- https://www.classcentral.com/course/swayam-earthquake-resistant-design-of-foundations-19849
- https://science.howstuffworks.com/engineering/structural/earthquake-resistant-buildings4.htm

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Design of foundation under earthquake loading by considering the influence of various design parameters that includes the liquefaction of soils due to earthquake.	L4, L5
CO2	Design parameters which affect the type of foundation and analyze the feasibility of the foundation	L3, L4

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x			x				x
CO2	x		x	x			x	x

Foundation Engineering in Difficult Ground			
Course Code	**MCGT215D**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 hours + 26 hours	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

- In-situ testing in difficult grounds.
- Design the foundations in earth movement conditions.
- Improve the ground conditions.

Module-1

Introduction: Classification, swelling and shrinkage, sensitivity, settlement and bearing capacity of clays, fissures in clay, glacial deposits and difficult rocks.

Site Investigation in difficult ground: Objectives, difficulties in determining the characteristics of the ground, remedial measures.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-2

In-situ testing and geophysical surveying: Introduction, penetrometers, SPT, CPT, plate bearing tests, pressure meters, seismic surveying, resistivity surveying **Ground water and foundations:** Introduction, effective stress theory, oil tanks on poor ground, effect of raising the ground water level – reclaimed land, foundation on the sea bed.	
Module-3	
Foundations and earth movements: Introduction, creep of rock masses, landslides, earthquake – primary and secondary effects, earthquake resistant design. **Design of foundations:** Introduction, general principles, strip and pad foundations, building on shrinkable soil, building on fill, raft foundation – variable soil and make up ground, pile foundation – choice, types; construction problems.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-4	
Stability of slopes in difficult ground: Introduction, mechanism of stability, strength of distorted clay, factor of safety, analysis, remedial measures	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-5	
Ground treatment: Introduction, ground water lowering techniques, electro-osmosis and electro-chemical stabilization, thermal techniques, grouts and grouting, reinforcements, other stabilization techniques, dynamic consolidation, pre loading, vibroflotation, stone columns.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for thecourse**.**

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

4. Each full question will have a sub-question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. Foundation in difficult ground – F G Bell, Butterworths & Co
2. Foundation Analysis and design – J E Bowles, Tata McGraw Hill

Reference Books:

1. Foundation Engineering – (4001) MJ Tomlinson - PHI

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc22_ce67/preview
- https://onlinecourses.nptel.ac.in/noc22_ce32/preview
- https://onlinecourses.nptel.ac.in/noc22_ce68/preview
- https://www.academia.edu/43121449/FOUNDATION_ENGINEERING_FOR_DIFFICULT_SUBSOIL_CONDITIONS

Skill Development Activities Suggested

- Insitu tests
- Slope stability analysis using software's
- Expert lectures on ground movements

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Develop the in-situ methods to evaluate the bearing capacity under different criteria.	L4, L5
CO2	Analyze and design the grounds in shrinking areas.	L4, L5
CO3	Overcome the construction problems by adopting suitable methods.	L5, L6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x		x			x	x	x
CO2	x			x	x	x		x
CO3	x		x	x		x		x

Reinforced Soil Structures			
Course Code	**MCGT216A**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40 hours + 26 hours	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

- Identify the soil suitable for reinforced earth.
- Identify the type of reinforcing material suitable for the project.
- Design the reinforced earth.

Module-1	
Historical background: Introduction to reinforced soil structures, comparison with reinforced cement concrete structures. **Reinforced Earth:** Principles, concepts and Mechanisms of reinforced earth	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-2	
Materials used, properties, laboratory testing and constructional details, metallic strips, metallic grids, geotextiles, geogrids, geomembranes and geocomposites, their functions and design principles	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-3	

Geotextiles: Introduction, design methods, function and mechanism, geotextile properties and test methods – physical, mechanical and hydraulic properties, construction methods and techniques using geotextiles	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-4	
Design applications of reinforced soil structures in pavements, embankments, slopes, retaining walls and foundations, reinforced soil structures for soil erosion control problems, geosynthetic clay liners	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-5	
Case studies of reinforced soil structures, discussion on current literature and design problems	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

   The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
6. Each full question will have a sub-question covering all the topics under a module.
7. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. **Designing with Geosynthetics** –Koerner R H (1994), Prentice Hall Inc.
2. **Reinforcements and Soil Structures** –Jones, CJEP (1996), Butterworth Publications
3. **Membranes in ground engineering–** Rankilor, P R (1985), John Wiley & Sons**.**

Reference Books:

1. **Soil Reinforcement with Geotextiles** – Jewel R A (1996), CIRIA
2. **Geotextiles hand book** – Ingold J S and Miller K S (1988), Thomas Telford Ltd.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105106052
- https://onlinecourses.nptel.ac.in/noc21_ce06/preview
- https://archive.nptel.ac.in/courses/105/106/105106052/
- http://www.nitttrc.edu.in/nptel/courses/video/105106052/L09.html

Skill Development Activities Suggested

- geosynthetics testing and methods
- gabion walls and reinforced walls
- field visits to understand soil reinforcement
- slope stability using reinforcement

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Design and incorporate the reinforced earth for the sites at weak soil sites	L2, L3, L4, L5
CO2	Design the pavements, embankments using reinforced earth to enhance the engineering properties of the soils	L2, L5
CO3	Identify the locations to implement the reinforced earth and find its	L5, L4

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x	x		x				x
CO2	x	x		x				x
CO3	x	x				x	x	x

Soil Structure Interaction			
Course Code	**MCGT216B**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 hours + 26 hours	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

- Make students understand soil structure.
- Understand stress-strain characteristics of soils.
- the mechanism of failure, the factors that affects the shear strength Structural behaviour with soils.

Module-1

Soil-Foundation Interaction: Introduction to soil-foundation interaction problems, Soil behavior, Foundation behavior, Interface behavior, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behavior, Time dependent behavior

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-2

Beam on Elastic Foundation- Soil Models: Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness. Plate on Elastic Medium: Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-3	
Plates on Elastic Continuum: Thin and thick rafts, Analysis of finite plates, Numerical analysis of finite plate.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-4	
Elastic Analysis of Pile: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-5	
Laterally Loaded Pile: Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Interaction analysis, Pile-raft system, Solutions through influence charts. An introduction to soil-foundation interaction under dynamic loads	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Assessment Details (both CIE and SEE) The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and	

SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.

1. The students will have to answer five full questions, selecting one full question from each module

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105105200
- https://www.youtube.com/watch?v=GKmW9j3qWfA
- http://www.nitttrc.edu.in/nptel/courses/video/105105200/lec9.pdf

Skill Development Activities Suggested

- Structure and soil behaviour
- Expert lectures
- Studying foundation behaviour with variation of soil friction and skin friction properties

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Analyze the behavior of the soil under elastic and plastic condition.	L2, L4
CO2	Predict the behavior of the pile under static and dynamic loads.	L2, L6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x	x						x
CO2	x	x		x			x	x

Rock Mechanics			
Course Code	**MCGT216C**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 hours + 26 hours	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

- Identify the type of the rock.
- Analyze the rock quality designation and also evaluate its strength.

  Determine the methods of tunnelling and mining.

Module-1

Classification of rocks, geological petro graphic and engineering. Index properties of rocks- porosity, density, permeability, durability and slake. Core recovery, RQD and its importance in engineering Stress-strain behaviour, factors influencing the strength of rock, temperature, confining pressure, strain rates, modes of failures of rocks.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-2

Failure theories of rocks Mohr's hypothesis, Griffith's Criteria, Muller's extension of Griffith's theory, elementary theory of crack propagation, failure of rock by crack propagation, effects of cracks of elastic properties.

Testing of rocks: Laboratory and field test, assessment of in-situ strength

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-3

Rock Foundation: Shallow and deep investigation for foundation design and construction aspect, slope stability analysis, mode of failures in rock. Design of slopes, excavation in rock and stabilization concepts	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-4	
Strengthening of rocks: Foundation treatment for dams and heavy structures by grouting and rock reinforcement. Methods and principles of grouting, principles of design of rock bolts	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-5	
Tunnels – Basic terminology and application, site investigations, methods of excavation of tunnels supports and stabilization, construction control and maintenance, tunnel ventilation, control of ground water and gas Underground Mining; mining methods, planning and design, mining equipment's and mining procedures, cause for subsidence and its remedial measures	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Assessment Details (both CIE and SEE) The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not	

less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of 25 Marks
2. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for thecourse.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. Introduction to Rock Mechnaics– Goodman (1976), John Wiley and Sons, NY
2. Fundamentals of Rock Mechanics – J C Jeager and N G W Cook (1976), Chapman and Hall, London
3. Geotechnology –Roberts, Pergamou Press ltd., Oxford

Reference Books:

1. Principles of Engineering Geology and Geotechniques– Krynine and Judd
2. Rock Engineering – Jhon A Franklin and Maurice b Dusseault, McGraw Hill
3. Rock mechanics for Engineers: Varma, B.P, Khanna Publishers
4. Rock mechanics & Design of structures: Obert, L & Duvall, W.I., John Wiley & Sons.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/105/105105212/
- https://nptel.ac.in/courses/105105212
- https://onlinecourses.nptel.ac.in/noc21_ce76/preview
- https://ibm.gov.in/writereaddata/files/09022014171840Rock%20mechanics.pdf
- https://www3.nd.edu/~cneal/PlanetEarth/Chapt-11a-Rock-Mechanics.pdf

Skill Development Activities Suggested

- Mining site visits
- Geology lab demonstration for understanding minerals
- Expert lectures and seminars
- Stability analysis using software's

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Identify the type of rock and to evaluate the bearing capacity of the rock.	L2, L4
CO2	Design and analyze the foundations and improvement techniques for the foundations on insitu rocks.	L4, L5
CO3	Design methodologies for mining and tunneling where rock is encountered.	L5

Mapping of COS and Pos:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							x
CO2	x		x	x		x		x
CO3	x		x	x		x	x	x

Critical State Soil Mechanics			
Course Code	**MCGT216D**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 hours + 26 hours	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

- Calculation of stress trajectories and deformations using stress invariants
- Elastic-plastic constitutive equation
- Approximate and exact method of solutions
  Constitutive models for unsaturated soils

Module-1

Basic concepts in critical stress concepts. Concepts of stress, strain, stress increment and strain increment, spherical and deviatoric tensors. Isotropic continuum for two elastic constants, Principal stress space, two alternate yield function, plastic potential function and normality condition. Isotropic hardening and stability criteria and numerical problems.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-2	
Seepage with two- and three-dimensional seepage, Mathematical solutions for the seepage below the sheet piles. One dimension consolidation, approximate and exact solution to the consolidometer test, granta-gravel, numerical problem	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-3	
Cam-clay model and critical state concept (including the compression, undrained tests on cam-clay), Plastic compressibility and the index tests, interpolation of data from axial tests on saturated clays with numerical problems	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-4	

Coulomb's failure equation and the choice of strength parameter- Coulomb's failure equation, Hvorselv's experiments on strength of clay, principal stress ratio. Failure mechanism and the residual strength on the sliding surface with numerical problems	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-5	
Two-dimension fields of limiting stresses- Coulomb's analysis of active and passive earth pressure, friction circle method, stability due to cohesion. Discontinuous limiting stress field solutions to the bearing capacity problems, upper and lower bound to a plastic collapse load. Basic equation for limiting stresses and their characteristics in purely cohesive soils and numerical solutions.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

3. Two Unit Tests each of 25 Marks
4. Two assignments each of 25 Marks or one Skill Development Activity of 50 marks to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be scaled down to 50 marks

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for thecourse.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reducedto 50.
2. The question paper will have ten full questions carrying equalmarks.
3. Eachfullquestionisfor20marks.Therewillbetwofullquestions(withamaximumoffoursub-questions)from eachmodule.
4. Each full question will have a sub-question covering all the topics under amodule.
5. The students will have to answer five full questions, selecting one full question from eachmodule.

Suggested Learning Resources:

Text Books:

1. An Introduction to the Mechanics of Soils and Foundation - through critical state soil mechanics- Atkinson J. H. (1993) - McGraw- Hill Co.
2. Soil Behavior and Critical State Soil Mechanics Wood, D.M (1991)- Cambridge university press
3. Crtical state Soil Mechanics- Andrew Schofield and Peter Worth (1967), Cambridge University Press
4. Soil Mechanics and Foundations, MuniramBudhu(4010), John Wiley & Sons, Inc.

Reference Books:

1. Soil Mechanics, T.W. Lambe and R.V. Whitman(1969). John Wiley &Sons,.
2. Geotechnical Engineering-Donold P Coduto Phi Learning Private Limited, New Delhi.

Web links and Video Lectures (e-Resources):

- https://freevideolectures.com/course/5324/advanced-soil-mechanics/46
- http://www-civ.eng.cam.ac.uk/geotech_new/publications/schofield_wroth_1968.pdf

Advanced Geotechnical Engineering Laboratory

Skill Development Activities Suggested

- Seepage problems and failures due to seepage of water
- Pore water pressure measurements
- Filter design criteria's

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	To understand the behavior of soil under normal and plastic condition	L2, L4
CO2	To develop a new model along with cam-clay.	L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x	x						x
CO2	x	x		x			x	x

Course Code	**MCGTL207**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	01:02:00	SEE Marks	50
Credits	02	Exam Hours	03

Course objectives:

- To understand the basic principles and methods designed for soil testing
- To determine the various index properties of soils
- To determine the engineering properties of soil
- To investigate the performance of various Soils

Sl.NO	**Experiments**
1	Determination of particle size by Wet sieve analysis and hydrometer analysis
2	Determination of OMC and MDD (Standard and Modified Proctor test)
3	Determination of Undrained shear strength parameters from shear tests (Direct, UCS, Triaxial shear, vane shear test)
4	California bearing ratio test (Soaked and Unsoaked tests)
5	To evaluate the bearing capacity and settlement of soils from --- by plate load test --- by cone penetration test (static and dynamic)

	--- by Standard penetration test
6	To determine the ground water table ---Using electrical resistivity method --- Using seismic refraction method
7	Determination of pH and organic solids
8	Determination of Chemical Properties of soil such as chloride, phosphorous, Potassium, Magnesium, calcium, Sodium etc.,
9	Determination of Geotechnical Properties of Geosynthetics (Tensile strength, Puncture Resistance, Aperture opening, Friction test.)
10	Slope stability Analysis, Design of open and pile Foundations, Retaining walls, Designs with Geosynthetics. (Designs using Software's)
	Demonstration Experiments (For CIE) if any
11	Demonstration of Free swell and differential free swell.
12	Field visit to understand Plate load Test and data interpretation
13	Analysis of laboratory and field test results using any of the available standard software

	packages and preparation of test report (Using Software's)
14	Filed visits for observing field shallow compaction techniques
15	Filed visits for observing field Deep compaction techniques

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Achieve Knowledge of Design and development of experimental skills.
- Understand the principles of design of experiments.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40%of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is 50 Marks.

The split-up of CIE marks for record/ journal and test are in the ratio 60:40.

- Each experiment to be evaluated for conduction with an observation sheet and recordwrite-up. Rubrics for the evaluation of the journal/write-up for hardware/softwareexperiments designed by the faculty who is handling the laboratory session and is madeknown to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experimentwrite-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to 30 marks (60% of maximummarks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 01 tests for 100 marks, test shall be conducted after the 14 the week of the semester.
- In test, test write-up, conduction of experiment, acceptable result, and proceduralknowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student’s performance and learningability.

- The test marks are scaled down to 20 marks (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of test is the total CIE marks scored by the student.

Semester End Evaluation (SEE)

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute; examiners are appointed by the University.

- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course

type, rubrics shall be decided by the examiners)

- Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.The duration of SEE is 03 hours

Text Books:

1. Manual of soil laboratory testing, K. H. Head, ELE International Ltd. Pentech press.
2. Shamsher Prakash, (1979) "Engineering Soil Testing", Nemichand, New Delhi.
3. Joesph E Bowles, "Engineering Properties of soil and their measurements", McGraw hill

Reference Books:

1. John T. Germaine, Amy V. Germaine, (4009) "Geotechnical Laboratory Measurements", John Wiely

William Lambe, (4003) "Soil Tsting for Engineers", MIT.

Suggested Learning Resources:

- https://nptel.ac.in/courses/105101160
- https://archive.nptel.ac.in/courses/105/101/105101160/
- https://www.elementaryengineeringlibrary.com/civil-engineering/soil-mechanics/
- https://www.youtube.com/watch?v=dkcs9JtB2Eo
- https://www.digimat.in/nptel/courses/video/105101160/L20.html

- https://onlinecourses.nptel.ac.in/noc22_ce81/preview
- https://nptel.ac.in/courses/105103182

FORENSIC GEOTECHNICAL ENGINEERING			
Course Code	MCGT258A	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2	SEE Marks	50
Credits	01	Total Marks	100
Examination type (SEE)	**MCQ**	Exam Hours	1 Hour

Course Learning objectives:

This course will enable students to

- Learning the soil properties for causing failures
- Identification of failure phenomenon
- New approach in the design aspects
- Improvisation of legal aspects in geotechnical engineering

Module-1

INTRODUCTION:

Historical failures of geotechnical structures (finite and infinite slopes, high embankments such as earthen dams, tunnels, excavations, foundations-shallow and deep, retaining structures etc.), characterization of failures, Inadequateness of Limit state design, principles and advantages of Mobilizeable strength design. Numerical problems

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-2

TECHNICAL FORENSIC INVESTIGATION: Collection of data, problem characterization, development of failure hypotheses, a realistic back- analysis, field observations and performance monitoring, modelling of failure hypothesis and quality control of formal and technical aspects of the work. Numerical problems.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-3	
GUIDELINES FOR FORENSIC INVESTIGATION OF GEOTECHNICAL CASES: Scope of the work, types of distress, diagnostic tests: field and laboratory tests, analysis, legal issues such as facts, interpretations, opinions, negligence **TECHNICAL ISSUES RELATED TO GEOTECHNICAL FAILURES:** Primary shortcomings causing failures, shortcomings in design, inadequate site investigations, unforeseen occurrences and phenomena, shortcomings in construction; recommendations to limit future occurrence of failures.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-4	
CASE HISTORIES: Construction of historic monuments, destruction due to environmental changes and survival of monuments among them, such as leaning tower of Pisa, Egyptian pyramids, tall structural foundations in Mexico City, pre historic caves in India etc., Consideration of geotechnical aspects such as settlement, shear strength, permeability, slope stability, etc., in construction of survived historic monuments as well as for the structures which have collapsed	

due to the new adjacent constructions or disturbances due to human activities etc., Numerical problems	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-5	
GEOTECHNICAL ENGINEERING AND LEGAL SYSTEM: Legal conflict of geotechnical failures, sanctions in the legal code of construction, geotechnical work for documentation of forensic cases; case studies of legal conflict of prominent structures (such as landslides, deep excavations, unexpected settlements of oil tanks, distress in soil walls, failure due to slow creep of hills etc.)	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks (25 marks out of 50) and for the SEE minimum passing mark is 40% of the maximum marks (20 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 40% of the maximum marks meant for SEE.

Suggested Learning Resources:

Text Books:

1. Forensic Geotechnical and Foundation Engineering – Robert W Day (4011)
2. Forensic Geotechnical Engineering – V V S Rao and G L Sivakumar Babu (4013), Springer India

Reference Books:

1. Indo-US Forensic Practices: Investigation Techniques and Technology – Shen En Chen, R Janardhanan, C Natarajan, Ryan Schmidt (4010), American Society of Civil Engineers

Web links and Video Lectures (e-Resources):

- https://online-learning.tudelft.nl/courses/forensic-engineering-learning-from-failures/

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	To predict the failure modes in geotechnical engineering before construction of structures.	L4, L6
CO2	To design the structures to overcome the failure in geotechnical engineering by understanding the behaviour of soils.	L4, L5
CO3	To frame the guidelines for avoiding the legal aspects of geotechnical failures by predicting and understanding the failure mechanism, their remedial measures before the construction of the foundations.	L4, L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							x
CO2	x	x		x			x	x
CO3			x				x	x

Environmental Geotechnical Engineering			
Course Code	MCGT258B	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2	SEE Marks	50
Credits	01	Total Marks	100
Examination type (SEE)	**MCQ**	Exam Hours	1 Hour

Course Learning objectives:

This course will enable students to

- Identify the contaminated soil and source contamination.
- Remedies for contaminated site.
- Study on Ground water contamination.
  Relation between contamination source and the soil & water.

Module-1

FUNDAMENTALS OF ENVIRONMENTAL GEOTECHNICAL ENGINEERING:

Scope of environmental geotechnical engineering - multiphase behavior of soil – role of soil in geoenvironmental applications – importance of soil physics, soil chemistry, hydrogeology, biological process – sources and type of ground contamination – impact of ground contamination on geoenvironmental - case histories on environmental geotechnical engineering problems.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-2

SOIL-WATER-CONTAMINANT INTERACTION:

Soil mineralogy characterization and its significance in determining soil behavior – soil-water interaction and concepts of double layer – forces of interaction between soil particles.

Concepts of unsaturated soil – importance of unsaturated soil in environmental geotechnical engineering problems - measurement of soil suction - water retention curves - water flow in saturated and unsaturated zone.

Soil-water-contaminant interactions and its implications – Factors effecting retention and transport of contaminants.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-3

WASTE CONTAINMENT SYSTEM:

Evolution of waste containment facilities and disposal practices – Site selection based on environmental impact assessment –different role of soil in waste containment – different components of waste containment system and its stability issues – property evaluation for checking soil suitability for waste containment – design of waste containment facilities.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-4

CONTAMINANT SITE REMEDIATION:

Site characterization – risk assessment of contaminated site - remediation methods for soil and groundwater – selection and planning of remediation methods – some examples of in-situ

remediation.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-5	
ADVANCED SOIL CHARACTERIZATION: Contaminant analysis - water content and permeability measurements – electrical and thermal property evaluation – use of GPR for site evaluation - introduction to geotechnical centrifuge modeling.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
1.	

Suggested Learning Resources:

Text Books

1. Geotechnical Practice for Waste Disposal – Daniel D E, Chapman and Hall, London
2. Hazardous Waste Management – Lagrega M D, Buckingham P L, Evans J C, McGraw Hill Inc, Singapore

Reference Books:

1. Designing with Geosynthetics -Koerner R M, Prentice Hall, New Jersey
2. Proceedings of International Symposium on Environmental Geotechnology (1986)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks (25 marks out of 50) and for the SEE minimum passing mark is 40% of the maximum marks (20 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 40% of the maximum marks meant for SEE.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105102160
- https://archive.nptel.ac.in/courses/105/102/105102160/
- https://www.issmge.org/filemanager/technical_committees/26/TC215/Environmental_Geotechnics.pdf

Skill Development Activities Suggested

- Visiting contaminant sites and observing new remediation techniques
- Visiting landfill sites
- Expert lectures on contaminant remediation

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	To measure the amount of contamination in soils and water.	L1, L2
CO2	To identify the source for contamination in soils and water.	L2, L3, L4
CO3	To know the interaction of soil, water and contaminants.	L2, L3, L4
CO4	Remedial measures for contaminated soils.	L4, L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x	x				x		x
CO2	x							
CO3	x							
CO4	x					x	x	x

OCCUPATIONAL SAFETY AND HEALTH MANAGEMENT IN CONSTRUCTION PROJECTS			
Course Code	MCGT258C	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2	SEE Marks	50
Credits	01	Total Marks	100
Examination type (SEE)	**MCQ**	Exam Hours	1 Hour

Course objectives:

The objectives of the course are to:

- Understand importance of personal safety, protective measures and training.
- Explain the nature of accidents in construction and hazard analysis.
- Understand various occupational hazards and emergency responses.
- Explain the ways to personal protection and various signs and signals.
- Understand about toxic substances and explosives and ergonomics

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Black board and power point presentations

Module-1

Introduction, nature of construction operation, brief introduction to OSHA, basics of personal safety, personal protective equipment, head protection, hearing, head, face protection, working safety, personal training. company and safety, society first culture, ethics and whistle blowing,

Module-2
The fatal accidents, fatal -4s, falls, protection against fall, safety monitoring systems, electrical injuries, caught-in between hazards, Accident theories, causes of accidents, cost of accidents, incident investigation techniques, impact of an accident on the employer, Time constraints, interruptions and distractions, accident prevention, Injured worker management, compensation laws, types of hazards, Job hazard analysis, Identifying potential hazards, detailed hazard analysis. Failure mode and effect
Module-3
Promoting safety, safety rules and regulations, prompting safety, work place violence, handling violence situation, policy reviews and preventing internal threats of violence, workplace security, general safety and health provisions, Employee emergency action plans, occupational health, occupational noise exposure, hazardous waste operations an emergency response,
Module-4
Personal protection and lifesaving equipment, general criteria, fire protection, equipment, prevention, temporary building, operations, flammable objects, signs, signals, and barricades, accident prevention signals.
Module-5
Toxic and hazardous substances, Asbestos, carcinogens, methods of complains, permissible exposure limits, blasting and use of explosives, surface transportation explosives, use of electric safety fuse, Ergnomics, related problems, ergonomic improvement by employers, engineering and management controls.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

1. Demonstrate the importance of safety measures in construction and possible accidents and risks.
2. Detect the possibility of accidents and find remedial measures appropriate to the situation.
3. Suggest plans to safeguard from occupational health issues and be able to demonstrate the applicability of various ergonomic measures.
4. Identify possible accidents in construction site and suggest preventive measures.
5. Identify toxic substances and carcinogens at a construction site and be able to suggest precautionary measures.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks (25 marks out of 50) and for the SEE minimum passing mark is 40% of the maximum marks (20 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 40% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. M.Rashad Islam, Construction Safety, Health and OSHA, Mc_Graw Hill Publications, First Edition, 2022, ISBN: 9781264257829.
2. Darill C. Hill, Construction Safety Management and Engineering, American Society of Safety Engineers, II-Edition, 2014.
3. S.C.Sharma, Vineeth Kumar, Safety, Occupational health and Environmental Management in Construction, Khanna Publishers, ISBN: 978-8174092700
4. David L Goetsch, Construction Safety and Health, II edition, Pearson Publications, 2016.
5. Phil Huges, Ed Ferret, Introduction to Health and safety in Construction, Elsevier Publications, 2007, ISBN: 978-0-7506-8111-7

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=LiPNy_WyCTU
https://www.youtube.com/watch?v=NIbacr2i1CQ
https://www.youtube.com/watch?v=S1tabDtr3LM
https://www.youtube.com/watch?v=3eCKfBkSUMU

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

-

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Demonstrate the importance of safety measures in construction and possible accidents and risks.	L2, L3
CO2	Detect the possibility of accidents and find remedial measures appropriate to the situation.	L2, L3
CO3	Suggest plans to safeguard from occupational health issues and be able to demonstrate the applicability of various ergonomic measures.	L2, L3
CO4	Identify possible accidents in construction site and suggest preventive measures.	L3, L4
CO5	Identify toxic substances and carcinogens at a construction site and be able to suggest precautionary measures.	L3, L4

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		X		X				
CO2		X		X				
CO3		X		X				
CO4		X		X				
CO5		X		X				

IoT AND SMART CITIES			
Course Code	MCGT258D	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2	SEE Marks	50
Credits	01	Total Marks	100
Examination type (SEE)	**MCQ**	Exam Hours	1 Hour

Course objectives:

The objectives of the course are to:

- To understand the basic concepts of smart cities and their energy sustainability in urban planning.
- To analyze the security, privacy, and ethics in smart cities planning and development.
- To perform process control and project management in smart cities.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Black board and power point presentations

Module-1

Smart City - Complexities of Smart Cities - Urban Network - Sensor Network - Role of Urban Networks - Trends in Urban Development - Community Resource Sensing. Urban Planning - Databases - Principles of Urban Planning - Data Organization - Role of Planning in Smart Cities.

Module-2

Energy Sustainability in Smart Cities 6 hours Energy - Decision Making - Energy as a catalyst for Sustainable Transformation - Cohesion and efficiency of smart cities. Security challenges in smart cities - Security threats in smart cities - IoT related safety measures for a safer smart city.
Module-3
Smart Cities Planning and Development 6 hours City Planning - Understanding Smart Cities - Dimensions of Smart Cities - Global standards and performance benchmark of smart cities - Financing smart cities development - Governance of smart cities.
Module-4
Process Control and Stabilization 7 hours Structural concept - Specific applications - Structural health monitoring - Process control and stabilization - Internet of Vehicle (IoV) Importance - Applications - Security issues - Perspectives on Intelligent Transport Systems (ITS) - ITS Highway safety perspective - Environmental aspects of ITS.
Module-5
Project Management in Smart Cities 6 hours Case studies on project management of smart cities: web applications and mobile based implementations. Contemporary issues in a smart city development.
Course outcome (Course Skill Set) At the end of the course the student will be able to: 1. Demonstrate the importance of safety measures in construction and possible accidents and risks. 2. Detect the possibility of accidents and find remedial measures appropriate to the situation.

3. Suggest plans to safeguard from occupational health issues and be able to demonstrate the applicability of various ergonomic measures.
4. Identify possible accidents in construction site and suggest preventive measures.
5. Identify toxic substances and carcinogens at a construction site and be able to suggest precautionary measures.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks (25 marks out of 50) and for the SEE minimum passing mark is 40% of the maximum marks (20 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 40% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. Carol L. Stimmel, Building Smart Cities Analytics, ICT, Design Thinking, 2016, 1 st edition, CRC Press, Taylor and Francis, UK
2. Andrea Vesco and Francesco Ferrero, Handbook of research on social, economic, andenvironmentalsustainability in the development of smart cities, 2015, 1st edition,
3. Information Science Reference, IGI Global, USA
4. La Scala, Massimo, et al., eds. From smart grids to smart cities: new challenges in optimizing energy grids. 2021, Vol. 2. John Wiley & Sons, USA
5. Angelakis, Vangelis, et al., eds. Designing, developing, and facilitating smart cities: urban design to IoT solutions. 2016, Springer, USA

Web links and Video Lectures (e-Resources):

1. Smart city government of India. http://smartcities.gov.in
2. Reconceptualizing Smart Cities: A Reference Framework for India https://www.niti.gov.in/writereaddata/files/document_publication/CSTEP%20Report%20Smart%20Cities%20Framework.pdf
3. Draft Concept Note on Smart City Scheme". Government of India - Ministry of Urban Development -martcitiesoftomorrow.com/wp-content/uploads/2014/09/CONCEPT_NOTE_

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Student seminars on related topics that is beyond syllabus.
- Discussion with experts and listening to expert lectures.
- Field visits and making reports on the learnings.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Leve
CO1	Ascertain and describe the basic concepts of smart and sustainable cities.	L2
CO2	Comprehend the knowledge of urban planning and sustainability in smart cities.	L2 & L3
CO3	Analyze the security issues and challenges of smart cities and their advancements.	L3
CO4	Incorporate project management, planning, and stack holders in the design and development of smart cities.	L2
CO5	Investigate the various ICT and data analytics to connect government, urban planners, universities, city developers, and communities.	L2

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	X									
CO2	X		X							
CO3	X		X							
CO4	X	X								
CO5	X		X							