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

M.Tech., Geotechnical Engineering

Semester-1

Finite Elements in Geotechnical Engineering			
Course Code	22 CGT11	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:00	SEE Marks	50
Total Hours of Pedagogy	40 Hours	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the basic principles of FEM and applications of FEM
- Understanding the capacity of the soil under different field conditions
- Design of shallow foundations under different loading condition and different environment conditions
- Design of footings for uniform settlement of all shallow foundations using FEM.

Module-1	
Introduction: General, General Description methods, Brief description of FEA for stress analysis problem, Finite element method v/s Classical method. FEM v/s FDM a brief history of FEM, need for studying FEM.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, Determining applications of FEM in different patterns of soil.
Module-2	
Basic equations in Elasticity: Introduction, Stress in typical element, Equations of equilibrium, Strains, Strain displacement equations, Linear constitutive law.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, Understanding equilibrium equations
Module-3	
Finite element basics: Introduction, Elements, Shape functions, Co-ordinate transformation, Strain displacement relations, Stiffness equations, Body forces, Surface tractions, Geotechnical considerations: effective stress method loadings, Initial stresses, excavation, fills.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, Understanding shape factors.
Module-4	
Variable – Elastic stress – Strain laws: Introduction, Bi-linear elastic model, K-G model, Hyperbolic model, Comparison of models. Critical state model: Introduction, the geometric model, Hardening law, Yield function, Flow rule, Stress- strain invariant relation, Stress – strain component relation, Parameter values, Examples.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through case studies and problem solving.
Module-5	
Seepage analysis: Introduction, Finite element discretization of seepage equation, computation of velocities and flows, treatment of free surface boundary. Analysis of jointed rock mass: Introduction, Characteristics and discontinuities in rock masses, models behaviour of jointed rocks, generalized plane strain analysis in rock mechanics, effective	

stress analysis in undrained rock masses.	
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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks** to attain the COs and POs

The sum of three 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. **Introduction to the Finite Element Method (1972),** Desai, C. S. and J.F, Abel. Van Nostrand Reinhold Company
2. **Finite element analysis in geotechnical engineering Vol 1&2, (1999)** - D M Potts & L Zdravkovic, Thomas Telford publishing, London
3. **Finite element analysis in geotechnical engineering,** D J Naylor & g N Pande(4012).
4. **FEM Analysis** by S.S. Bhavikatti, New Age International Publishers.

Reference Books:

1. **Introduction to the Finite Element Method(1993)** J. N. Reddy - McGraw-Hill Publishers,
2. **Finite element analysis - Theory and programming(1994)** Krishna Murthy, C. S. -Tata McGrawHill,
3. **Finite element Methods(1971)** Zienkiewicz, O. C. -, McGraw-Hill Publishers,

Web links and Video Lectures (e-Resources):

- **https://nptel.ac.in/courses/105106051**
- **https://archive.nptel.ac.in/courses/105/105/105105041/**
- https://www.sjsu.edu/me/docs/hsu-Chapter%2011%20Finite%20element%20analysis_04-25-19.pdf

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 basic concepts of finite element analysis in general and the transition from structural engineering aspects to geotechnical engineering aspects	L2,L3,L4,L5
CO2	To understand the finite element techniques for seepage analysis and joint rock masses	L1,L2,L3,L6
CO3	In Finite element applications in design and Analysis of bearing capacity of the soil for shallow foundations	L1,L2,L3,L6
CO4	To understand and working of software's used in design which are faster than the analytical analysis	L2,L4,L5,L6

Mapping of COS and POs

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

Semester - I

Geotechnology and Advanced Soil Testing

Course Code	**22CGT12**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	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	Determining 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 **20 Marks**
2. Two assignments each of **10 Marks/One Skill Development Activity of 20 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 experimentsshall 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 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

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)**, 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://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	22 CGT13	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:02	SEE Marks	50
Total Hours of Pedagogy	40 hours+26 hours	Total Marks	100
Credits	04	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:

3. Three Unit Tests each of **20 Marks**
4. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three 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:

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

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	×	×	-	-	-	-

Advanced Soil Mechanics			
Course Code	22 CGT14	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:

5. Three Unit Tests each of **20 Marks**
6. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three 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:

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

Suggested Learning Resources:

Text Books:

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

Reference Books:

4. **Geotechnical Engineering**- Donold P Coduto Phi Learning Private Limited, New Delhi
5. **Soil Mechanics and Foundation Engg.- Muni Budhu (4010)**, 3rd Edition, John Wiely& Sons
6. **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=PLwdnzlV3ogoVFn-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	×	×	-	-	-	-

Design of Deep Foundations

Course Code	22 CGT15	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:

7. Three Unit Tests each of **20 Marks**
8. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three 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:

16. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
17. The question paper will have ten full questions carrying equal marks.
18. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
19. Each full question will have a sub-question covering all the topics under a module.
20. 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
7. **Foundation Engineering Hand Book (1990),** H. F. Winterkorn and H Y Fang GalgotiaBooksource

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	×	×	-	-	-	-

ResearchMethodologyand IPR			
CourseCode	**22RMI16**	CIEMarks	50
TeachingHours/Week(L:P:SDA)	3:0:0	SEEMarks	50
TotalHoursofPedagogy	40	TotalMarks	100
Credits	03	ExamHours	03

CourseLearningobjectives:

- Tointroducevarioustechnologiesofconductingresearch.
- Tochooseanappropriateresearchdesignforthechosenproblem.
- Chooseappropriatetoolfortheconductionofresearch.
- Toexplaintheartofinterpretationand theartof writingresearchreports.
- Toexplainvariousformsoftheintellectualproperty,itsrelevanceandbusinessimpactinthechangingglobalbusinesenvironment
- TodiscussleadingInternationalInstrumentsconcerningIntellectualPropertyRights.

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research,TypesofResearch,ResearchApproaches,SignificanceofResearch,ResearchMethodsversusMethodology,Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria ofGood Research, and Problems Encountered by Researchers in India.**Defining the Research Problem:** ResearchProblem,SelectingtheProblem,NecessityofDefiningtheProblem,TechniqueInvolvedinDefiningaProblem, AnIllustration

Teaching-Learning Process	Chalkandtalk/PPT/casestudy

Module-2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your researchproblem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings,How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoreticalframework,Developingaconceptual framework,Writingaboutthe literaturereviewed.

Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, ImportantConceptsRelatingtoResearchDesign,DifferentResearchDesigns,BasicPrinciplesofExperimentalDesigns,ImportantExperimental Designs.

Teaching-Learning Process	Chalkandtalk/PPT/casestudy/webcontent

Module-3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample SurveyversusCensusSurvey,TypesofSamplingDesigns.**MeasurementandScaling:**QualitativeandQuantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources ofError in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, MultidimensionalScaling, Deciding the Scale.**Data Collection:** Experimental and Surveys, Collection of Primary Data,CollectionofSecondaryData,SelectionofAppropriateMethodforDataCollection,CaseStudyMethod.

Teaching-Learning Process	Chalkandtalk/PPT/casestudy/webcontent

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, TestStatisticsandCriticalRegion,CriticalValueandDecisionRule,ProcedureforHypothesisTesting,HypothesisTestingforMean,Proportion,Variance,forDifferenceofTwoMean,forDifferenceofTwoProportions,forDifferenceofTwoVariances,P-Valueapproach,PowerofTest,LimitationsoftheTestsofHypothesis.**Chi-square** **Test:** Testof Difference ofmorethanTwoProportions,Test ofIndependenceofAttributes,TestofGoodnessofFit,

CautionsinUsingChiSquareTests	
Teaching-Learning Process	Chalkandtalk/PPT/casestudy/webcontent
Module-5	
InterpretationandReportWriting: MeaningofInterpretation,TechniqueofInterpretation,PrecautioninInterpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report,Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing ResearchReports.**IntellectualProperty:**TheConcept,IntellectualPropertySystem in India,DevelopmentofTRIPSComplied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The GeographicalIndications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varietiesand Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets,Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales forProtection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation(WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right ofPriority,CommonRules,Patents,Marks,IndustrialDesigns,TradeNames,IndicationsofSource,UnfairCompetition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection ofLiteraryandArtisticWorks,BasicPrinciples,DurationofProtection,TradeRelatedAspectsofIntellectualProperty Rights(TRIPS) Agreement, Covered under TRIPS Agreement,Features of the Agreement, Protection ofIntellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, IndustrialDesigns,Patents, Patentable Subject Matter, Rights Conferred,Exceptions, Term of protection, Conditions onPatentApplicants,ProcessPatents,OtherUsewithoutAuthorizationoftheRightHolder,Layout-Designsof IntegratedCircuits,ProtectionofUndisclosedInformation,EnforcementofIntellectualPropertyRights,UNSECO.	
Teaching-Learning Process	Chalkandtalk/PPT

AssessmentDetails(bothCIEandSEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. Theminimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of themaximum marks of SEE.A student shall be deemed to have satisfied the academic requirements and earned thecredits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sumtotaloftheCIE(ContinuousInternalEvaluation)andSEE(SemesterEndExamination)takentogether.

ContinuousInternalEvaluation:

1. ThreeUnitTestseachof **20Marks**
2. Twoassignmentseachof**20Marks**or**oneSkillDevelopmentActivityof40marks** toattaintheCOsandPOs

Thesumofthreetests,twoassignments/skillDevelopmentActivities,willbe**scaleddownto50marks**

CIEmethods/questionpaperisdesignedtoattainthedifferentlevelsofBloom'staxonomyaspertheoutcomedefinedfor thecourse.

SemesterEndExamination:

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

SuggestedLearningResources:

TextBooks:

1. *Research Methodology: Methods and Techniques*, C.R. Kothari, Gaurav Garg,New Age International,4th Edition,2018..DouglasEComer,"InternetworkingwithTCP/IP,Principles,ProtocolsandArchitecture,"PHI,6thEdition
2. *Research Methodology a step-by-step guide for beginners.* (For the topic Reviewing the literature under module2),RanjitKumar,SAGEPublications,3rdEdition, 2011.

ReferenceBooks:

1. *ResearchMethods:theconciseknowledgebase,* Trochim,AtomicDogPublishing,2005.
2. *ConductingResearchLiteratureReviews:FromtheInternettoPaper*,FinkA,SagePublications,2009.

WeblinksandVideoLectures(e-Resources):

- https://www.youtube.com/watch?v=A7oioOJ4g0Y&list=PLVf5enqoJ-yVQ2RXUl6mCfLPf3J_JUfoc

Courseoutcome(CourseSkillSet)

Attheend ofthecoursethestudentwillbeableto:

Sl. No.	Description	Bloom's Level
CO1	Conduct research independently	L2
CO2	Choose research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.	L2
CO3	Statistically interpret the data and draw inferences	L2

MappingofCOSandPOs

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

Geotechnical Engineering Laboratory-I			
Course Code	**22CGTL17**	CIE Marks	505
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 Specific gravity and Moisture content
2	Determination of In-situ density and relative density of sand
3	Determination of particle size by Wet sieve analysis and hydrometer analysis
4	Determination of Atterberg's Limits
5	Determination of OMC and MDD (Standard and Modified Proctor test)
6	Determination of coefficient of permeability (Variable head method and Constant head method)
7	Determination of Undrained shear strength parameters from shear tests (Direct, UCS, Triaxial shear, vane shear test)
8	California bearing ratio test (Soaked and Unsoaked tests)
	Demonstration Experiments (For CIE) if any
9	Demonstration of different methods determining water contents
10	Field demonstration to understand sampling techniques and samplers.
11	Demonstration of Free swell and differential free swell.
12	Demonstration of percent swell – swell pressure, in one dimension-swell and load test classification of expansive soils

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 observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge 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 learning ability.
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and average marks of two tests 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

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/

Semester- 2

Soil Dynamics and Machine Foundations			
Course Code	**22CGT21**	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 study vibration concepts in soils like damping, wave propagation, resonance and effect of modes of vibrations •To study dynamic soil properties. Determination of dynamic properties by field and laboratory tests •Effect of liquefaction and anti liquefaction measures •To study vibration isolation, machine foundation design			
Module-1			
Theory of vibration- single degree, two degree and multi degree of freedom system. Free and forced vibration, transient response, resonance and its effects.			
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving		
Module-2			
Wave Propagation – theory and application to dynamic problems, dynamic soil properties- general, laboratory and field methods, factors affecting. Different properties, vibration inducing and measuring instruments.			
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving		
Module-3			
Shear strength and liquefaction of soils- stress, strain, strength characteristics of soils under dynamic loads. Factors affecting, resonance column test, triaxial test under dynamic loads. Liquefaction of soils and factors influencing liquefaction, dynamic earth pressure, retaining wall problems under dynamic loads.			
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving		
Module-4			
General principles of machine foundation design- introduction, design criteria, types and requirements of machine foundations, foundations for reciprocating machines, foundations for forge hammers, foundations for turbo generators			
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving		
Module-5			
Vibration isolation- introduction, mechanical isolators, isolation by artificial barriers, active and passive isolation, case histories of foundation of isolation.			
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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks** to attain the COs and POs

The sum of three 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. **Soil Dynamics and Machine Foundation (4010),** Swami Saran, GalgotiaPublicationsPvt. Ltd**.**
2. **Soil Dynamics(1981)-** Prakash, S. McGraw Hill Book Company

Reference Books:

1. **Foundation for Machines (1998)** Prakash, S. and Puri, V. K.: Analysis and Design, John Wiley & Sons,
2. **Vibration Analysis and Foundation Dynamics(1998)-**Kameswara Rao, N. S. V., Wheeler Publication Ltd.,
3. **Vibrations of Soils and Foundations(1970)** Richart, F. E. Hall J. R and Woods R. D., Prentice Hall Inc.,
4. **Principles of Soil Dynamics (4002)** Das, B. M., PWS KENT publishing Company, Boston.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105101005
- https://www.vssut.ac.in/lecture_notes/lecture1623481301.pdf
- http://www.mdp.eng.cam.ac.uk/web/library/enginfo/textbooks_dvd_only/soilmechs/SoilDynamics.pdf
- http://www.nitttrc.edu.in/nptel/courses/video/105101005/lec31.pdf

Skill Development Activities Suggested

- Workshops on soil dynamics
- Model exhibition
- Field visits and industrial visits to observe machine foundations
- NPTEL courses

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	To develop a mechanism to design the foundations for resisting vibrations and achieve static equilibrium conditions of structures	L2, L5
CO2	To understand the classical geotechnical failures due to liquefaction and mitigate the same.	L4, L5
CO3	Design of foundations in large structures like power plants, other industrial buildings etc., for analyzing the vibrating waves which can be isolated and measures for achieving safety of the adjacent foundations	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	x		x
CO3	x	x		x		x	x	x

Semester - 2

Subsurface Investigations and Ground Improvement Techniques			
Course Code	**22CGT22**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

This course will enable students to

- Identify the soil type of soil from a job site or in a professional setting, determine that soil's properties based on type and evaluate design decisions from your understanding of that soil's properties.
- 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 explore the site improvement techniques

MODULE-1

SITE INVESTIGATION:

Planning and experimental programmed, investigations, exploration for preliminary design, exploration for detailed design, Geo-physical explorations, soundings, probing, boring, boring methods, excavation methods for explorations, ground water investigations, rock boring, miscellaneous exploratory techniques. Numerical problems.

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

MODULE-2

SAMPLING AND IN-SITU FIELD TESTS: Types of samples, samplers, preservation, shipment and storage of samples, bore log, pore pressure measurements, core recovery, rock strength, rock quality designation

In-situ field testing and laboratory investigation of soils and rock, measurement techniques: SPT, SCPT, DCPT, pressure meter, dilatometer, plate load test. Numerical problems.

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

MODULE-3

DATA INTERPRETATION: Data interpretation for determination of engineering properties of soils and their application to geotechnical design, preparation of site investigation reports

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

MODULE-4

SITE IMPROVEMENT: General methods of stabilization – shallow and deep, factors governing suitable method, compaction,

DRAINAGE: soil and filter permeability, filter criteria, drainage layout and pumping system,

Pre-compression and consolidation: principles, sand drains, pore pressure distribution, electro-osmotic and chemical osmotic consolidation. Numerical problems

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

MODULE 5	
STABILIZATION: Mechanical stabilization, lime, cement, bitumen, chemical etc. Grouting: Injection and principles, grouting pressure criteria, grouting equipment, injection chemicals, Thermal methods: heating and cooling effects on soils, equipment, **Miscellaneous:** moisture barriers and preventing techniques	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

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

Sl.NO	Experiments
1	Water Absorption Test for rocks
2	Specific Gravity test for rocks
3	Determination of hardness of rocks (Rock Hardness Test)
4	Determination of Compressive Strength of rock,
5	Brazilian Test and Point load Index Test.
6	Determination of Elastic Properties of Rocks
7	Determination of earth pressure by Pressuremeter test
8	Determination of earth pressure by Dilatometer test
9	Site visits for observing soil reinforcements, soil nailing and grouting techniques
10	Field visit to understand dewatering techniques (sumps and ditches , well point system, electro osmosis)
11	Field visit to understand Plate load Test and Pile load tests
12	Field visit to understand wash boring and rotary boring techniques

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 **20 Marks**
2. Two assignments each of **10 Marks/One Skill Development Activity of 20 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 experimentsshall 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 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 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. **Engineering Principles of Ground Modifications** – Hausmann, McGraw Hill.
2. **Foundation Analysis and Design** – J E Bowles, Tata McGraw Hill.
3. **Subsurface Exploration and Sampling of Soils for Civil Engg. Purposes** – Hvorslev M J,
4. **Ground Improvement Techniques by P**. Purushotham Raj.
5. Foundation Engineering by S P Brahma

Reference Books:

1. **Soil Mechanics, T.W. Lambe and R.V. Whitman.** John Wiley & Sons, 1969.
2. Geotechnical Engineering- Donold P Coduto Phi Learning Private Limited, New Delhi
3. Geotechnical Engineering- Shashi K. Gulathi& Manoj Datta. (4009), "Tata Mc Graw Hill.
4. **Soil Mechanics and Foundation Engg.- Muni Budhu (4010), 3rd Edition, John Wiely& Sons**
5. **Soil Mechanics for Road Engineers - HMSO**

Web links and Video Lectures (e-Resources):

- **https://www.slideshare.net/arpitkvnfc/soil-exploration-part-i**
- **https://nptel.ac.in/courses/105108069**
- **https://nptel.ac.in/courses/105108075**
- **http://www.gpcet.ac.in/wp-content/uploads/2018/04/UNIT-1.pdf**

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

- Mini projects on stabilization
- Field visits to observe field tests of soil and ground improvement techniques
- Blending methods of soil to improve the properties

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	To explore and understanding the behavior of soils using index, compaction and engineering properties for the design of foundations.	L2, L4, L5
CO2	To adopt suitable ground improvement techniques to alter the geotechnical properties to suit any type of foundations based on the load coming from the super structure on to the foundation and soil	L3, L4
CO3	To explore the behavior of soils under critical state and in dynamic cases	L2, L3, L4

Mapping of COS and POs

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

Semester- 2

Earth and Rock Fill Dams			
Course Code	**22CGT231**	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

- Know the characteristics of the soil for design of earthen dam.
- Effect of pore pressure in earthen dams.
- Effect of fissures and folds of rock on foundation of earthen dam.

Module-1

Introduction: Necessity of Earth and Earth-rock fill dams, types, typical embankment dam sections
Site Selection and Exploration: Factors influencing location and alignment of the dam, foundation subsurface exploration and studies of embankment construction material
Factors influencing Design: Availability of material for construction, character of foundation, climate, shape and size of valley, river diversion, probable wave action, time available for construction, function of the reservoir and earthquake activity

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

Module-2

Design details: Material, location and inclination of earth core, shell materials and embankment side slopes, free board, crest width and camber. Filter zones, curving embankment for arch action and raising earth dams. Design provisions to control construction and draw down pore pressures. Berms, slope protections, internal drainage systems
Measurement of pore water pressure and movements: Purpose and types of instruments, piezometer, devices for measuring movements, USBR measurements of pore water pressure and embankment compression, compression of rock fill embankment sections, during construction and post construction foundation settlement, foundation spreading, observation and measurement of leakage

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

Module-3

Stability analysis: Zones of planes of weakness in foundation, linear failure, plastic failure, composite failure, bearing capacity failure, stability analysis of embankment by Taylor's modified method suggested by Sherard et al., wedge method, stability analysis in three-dimension, stability during construction, full reservoir and drawdown conditions
Special Design problems and details: Design considerations in earthquake, ground movements, earthquake intensity scales, periods and amplitudes of ground motion, influence of foundation material, earthquake waves, seiches, slope stability analysis during earthquake as per BIS, problems in loose sand, soft clay and silt foundation

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

Module-4

Treatment of rock foundations and abutments: types of rock foundation, object of grouting, evaluation of necessity of grouting, planning grouting details, blanket grouting, drilling equipment, size and direction of holes, washing and pressure testing of holes, grouting equipment, procedures for grouting, pressure and consistency of grout, stopping surface leakage, surface treatment of rock foundation and abutments. Earth compaction against rock foundations and abutments, grouting through completed earthen embankments, drainage holes, grouting and drainage galleries. **Earth dams on pervious soil foundations:** Methods of foundation treatment, preventing under seepage with complete vertical barriers and grouting, reducing under seepage with partial vertical cutoffs and horizontal upstream impervious blankets, controlling under seepage by regulation of leaks and relief wells	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-5	
Embankment Construction: Equipment for excavating, hauling, spreading, blending, compacting and separating oversized rocks and cobbles, construction procedures and quality control of impervious and semi-pervious embankment sections, handling dry and wet materials, construction problems caused by fines, construction procedures of hard and soft rock fill embankments, field test on rock fill embankments, slope treatment and rip-rap	
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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
3. to attain the COs and POs

The sum of three 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. **Earth and earth-rock dams** - Sherard J L, Woodward R J, Gizienski S F and Clevenger W A, John Wiley & Sons, NY
2. **Earth and rockfill dam engineering** – Sowers G P and Sally H L, Asia Publishing House, New Delhi
3. **Engineering for Dams** – Creager W P, Justin J D and Hinds J, John Wiley & Sons, NY

Reference Books:

Indian storage resources with earthen dams – Strange W L, R&FNSpon Ltd., London

Web links and Video Lectures (e-Resources):

- https://apps.dtic.mil/sti/pdfs/ADA402893.pdf
- https://www.youtube.com/watch?v=jbYy-swM_to
- https://www.youtube.com/watch?v=hJXRt-iN_as
- https://slideplayer.com/slide/4156335/.

Skill Development Activities Suggested

- Model exhibition on earthen dams and rockfill dams
- Workshops and seminars
- Industrial visits to observe embankment construction and dams

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	To design the rock and earth fill dams.	L5
CO2	To understand the mechanism of grouting and its application in rocks.	L3, L4
CO3	For analyzing the complex geotechnical problems for the design of earth and rock fill dams.	L3, L4, L5

Mapping of COS and POs

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

Semester- 2

Expansive Soil Engineering			
Course Code	**22CGT232**	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 expansive soils.
- Understand the behavior of such soils and to study the remedial measures for safety of structures.

Module-1

INTRODUCTION:
Origin, distribution of expansive soils, recognition and identification of expansive soils – clay mineral, x-ray diffraction, DTA, electron microscopy, classification, free swell, shrinkage index, swelling potential and swelling pressure – methods of determination, factors influencing.
HEAVE PREDICTION: Introduction, soil suction, measurement of soil suction – tensiometers, axis translation, filter paper method, psychrometers, osmotic method, heave prediction based on oedometer tests, based on soil suction tests

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

Module-2

DESIGN ALTERNATIVES: Introduction, drilled pier and beam foundation, mat foundation, under-reamed pile foundation, general conditions for under reamed piles, design and construction
DESIGN FOR HIGHWAY AND AIR-FIELD PAVEMENTS: Introduction, general principles of pavement design, design features and treatment methods for expansive soil subgrades, air-field procedures

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

Module-3

TREATMENT OF EXPANSIVE SOILS: Introduction, removal and replacement, remolding and compaction, pre-loading, pre-wetting, stabilization – lime, cement, fly ash, application methods, moisture control, electro chemical treatments
REMEDIAL MEASURES: Introduction, remedial measures for buildings and pavements, case histories

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

Module-4

METHODS OF CONSTRUCTION ON EXPANSIVE SOILS: Introduction, sub-base preparation, constructional and water – protection measures, maintenance and rehabilitation of structures founded on expansive soils

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

Module-5

SWELL – SHRINK BEHAVIOUR OF EXPANSIVE SOILS: Introduction, investigation of foundation movements, cyclic behaviours, factors affecting cyclic behaviour, case histories	
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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
3. to attain the COs and POs

The sum of three 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. **Foundations on Expansive Soil** -F H Chen, Elsevier Science Publishing Company, NY
2. **Construction of buildings on expansive soils** -E A Sorochan, Oxford & IBH Publications
3. **Expansive soils – Problems and practice in foundation and pavement engineering**– John D Nelson and Debora J Miller, John Wiley & Sons.

Reference Books:

1. **Soil Mechanics for Unsaturated Soils** – D J Fredlund and H Rahardjo, John Wiley & Sons

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/103/105103214/
- https://onlinecourses.nptel.ac.in/noc22_ce21/preview
- https://www.youtube.com/watch?v=ChrRArjR23A

Skill Development Activities Suggested

- Conducting field tests to identify the expansive soils
- Testing of soil to identify the structure of expansive soil
- Lab tests on expansive soils
- Case studies on expansive soils

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Classify the heaving soils and to predict their swell and shrinkage behavior.	L2, L4
CO2	Provide proper remedy to the swelling soils.	L5
CO3	Design the appropriate foundation based on the swelling characteristics.	L3, L4, L5

Mapping of COS and POs

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

Semester- 2

Foundation Engineering in Difficult Ground			
Course Code	**22CGT233**	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.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
3. to attain the COs and POs

The sum of three 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. **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

Semester- 2

Rock Mechanics			
Course Code	**22CGT234**	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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
3. to attain the COs and POs

The sum of three 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. **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

Semester- 2

Case Histories in Geotechnical Engineering			
Course Code	**22CGT235**	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

- Understanding the failure mechanism in geotechnical engineering.
- Evaluating the soil as different construction materials and its behavior.
  Role of soil in past and future in construction industry.

Module-1	
Geotechnical problems in civil engineering and in foundations . Soil as construction material in slopes and excavations. Geotechnical problems in underground and earth retaining structures**.**	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-2	
Behavior of different soils under different foundations and different environmental conditions. Calculated risk and safety factors in applied soil engineering	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-3	
Past and future of applied soil mechanics, Effect of pore water pressure	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-4	
New concepts in consolidation settlements, settlements and bearing capacity	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-5	
Case histories- typical cases of performance failure of representative of soil engineering projects namely shallow and deep foundations, slope stability, earth dams, retaining structures, machine foundations 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. 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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
3. to attain the COs and POs

The sum of three 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. **Fundamentals of soil behaviour –** J K Mitchel. (4012)- McGraw- Hill Co.
2. **Soil Mechanics SI version-** Lambe, T. W. and Whitman, R. V, .(4011) John Wiley & Sons
3. **Soil Mechanics and Foundations,** MuniramBudhu(4011), John Wiley & Sons, Inc.
4. **Soil Mechanics,** JE.Bowles (4012), McGraw Hill

Reference Books:

1. **Soil Mechanics, Terzaghi and Peck** (1969)**.** John Wiley &Sons,.
2. **Geotechnical Engineering**- Donold P Coduto Phi Learning Private Limited, New Delhi
3. **Literatures for Case Histories from known Journals (ASCE, Elsevior, Canadian Geotechnical Journal etc.,)**
4. **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/105101196
- https://academicjournals.org/journal/IJPS/article-full-text-pdf/6639B5F27631
- https://ascelibrary.org/doi/abs/10.1061/40971(310)29
- https://books.google.co.in/books?hl=en&lr=&id=xL-eoFCYMrQC&oi=fnd&pg=PR5&dq=Case+Histories+in+Geotechnical+Engineering&ots=xVbILBetvH&sig=2zmsDxArUcj4rfXTkOjG6sqFZII#v=onepage&q=Case%20Histories%20in%20Geotechnical%20Engineering&f=false

Skill Development Activities Suggested

- workshops and seminars
- visiting sites for understanding case histories of structures
- advanced testing methods

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	To develop a model for the behaviour of the soil from the existing or past data.	L4, L5
CO2	To prediction the failures based on the material and soil behavior.	L4, L5, L6
CO3	To develop new approaches for design of stable structures by understanding the case histories for failure of foundation structures and arrive at classical geotechnical behaviour to contract the failures.	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
CO3	x		x		x			x

Semester- 2

Pavement analysis and design			
Course Code	**22CGT241**	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 pavement and to know the stress distribution.
- Learn the deflection criteria in soils for different pavements.

To know the characteristics of the rigid pavements and flexible pavements.

Module-1

INTRODUCTION:

Types and component parts of pavements, factors affecting design and performance of pavements, highway and airport pavements

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

Module-2

STRESSES AND DEFLECTION IN FLEXIBLE PAVEMENTS: Stresses and deflections in homogeneous masses, two, three and multi-layer theories, wheel load stresses, various factors in traffic wheel loads, ESWL of multiple wheels, repeated loads and EWL factors, sustained loads, pavement behaviour under transient traffic loads

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

Module-3

FLEXIBLE PAVEMENT DESIGN METHODS FOR HIGHWAYS AND AIRPORTS: Empirical, semi-empirical and theoretical approaches, development, principle, design steps, advantages and application of the different pavement design methods including IRC, AASHTO and Asphalt Institute methods

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

Module-4

STRESSES AND DEFLECTIONS IN RIGID PAVEMENTS: Types of stresses and causes, factors influencing the stresses, general considerations in rigid pavement analysis, EWL, wheel load stresses, warping stresses, frictional stresses, combined stresses

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

Module-5

RIGID PAVEMENT DESIGN:

Types of joints in cement concrete pavements and their functions, joint spacing, design of CC pavement for roads and runways, design of joint details for longitudinal joints, contraction joints and expansion joints, IRC method of design by stress ratio method, Design features of CRCP, SFRC and ICBP, Problems, design of continuously reinforced concrete pavements

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

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
3. to attain the COs and POs

The sum of three 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. **Principles of Pavement Design** – Yoder E J, Witczak, John Wiley and Sons
2. **Soil Mechanics for Road Engineers** – RRl and DSIR, HMSO Publication
3. **Design of Functional Pavements** – Huang, McGraw Hill Book Co.
4. **Development in Highway Engineering** – Pell Peter S, Applied Science Publishers, London
5. **Pavement Analysis–** Huang, Elsever Publications

Reference Books:

1. **IRC Publications**
2. **CMA Handbook**

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105104098
- https://archive.nptel.ac.in/content/storage2/courses/105104098/TransportationII/lecture3/3-2-design-principle.htm
- https://vssut.ac.in/doc/Transportation-1_Lecture-Note.pdf

Skill Development Activities Suggested

- Studying basic pavement material properties
- Testing of pavement materials
- Pavement design 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	To design flexible and rigid pavements at different soil conditions.	L2, L5
CO2	To understand the behavior of the stresses and deflections at different loading and soil conditions.	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

Semester- 2

Environmental Geotechnical Engineering			
Course Code	**22CGT242**	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 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 geoenvironment - 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

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
3. to attain the COs and POs

The sum of three 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. **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)**

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

Semester- 2

Ground Water and Hydrology			
Course Code	**22CGT243**	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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
3. to attain the COs and POs

The sum of three 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. **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:

1. **Soil Mechanics, T.W. Lambe and R.V. Whitman**(1969)**.** John Wiley &Sons,.
2. **Foundations and slopes**- Attikinson (1981), McGraw Hill, New Delhi
3. **Seepage, Drainage and Flownets –** Cedergren H R(1997).-,John Wiely& Sons.
4. **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

Semester- 2

Critical State Soil Mechanics			
Course Code	**22CGT244**	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:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
3. to attain the COs and POs

The sum of three 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. **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

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

Semester- 2

Soil Structure Interaction			
Course Code	**22CGT245**	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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
3. to attain the COs and POs

The sum of three 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. **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/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

Geotechnical Engineering Laboratory-II			
Course Code	**22CGTL26**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:2:0	SEE Marks	50
Credits	02	Exam Hours	03

Course objectives:

- The objective of this course is to make students to learn principles and design of experiments.
- To investigate the performance of various Soils

Sl.NO	Experiments
1	Determination of shear strength parameters by triaxial (CD and CU) test
2	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
3	To determine the ground water table ---Using electrical resistivity method --- Using seismic refraction method
4	Determination of shear modulus, damping ratio and liquefaction of soils by resonant column method
5	Determination of pH and organic solids
6	Determination of Chemical Properties of soil such as chloride, phosphorous, Potassium, Magnesium, calcium, Sodium etc.,
7	Determination of Geotechnical Properties of Geosynthetics (Tensile strength, Puncture Resistance, Aperture opening, Friction test.)
8	Slope stability Analysis, Design of open and pile Foundations, Retaining walls, Designs with Geosynthetics. (Designs using Software's)
	Demonstration Experiments (For CIE) if any
9	Field visit to understand Plate load Test and data interpretation
10	Analysis of laboratory and field test results using any of the available standard software packages and preparation of test report (Using Software's)
11	Filed visits for observing field shallow compaction techniques
12	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:

During this course, students will be trained :

- 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 observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge 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 learning ability.
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and average marks of two tests 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
2. William Lambe, (4003) "Soil Tsting for Engineers", MIT.

Suggested Learning Resources:

- 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
- https://archive.nptel.ac.in/content/storage2/courses/105108069/mod01/lec01.pdf

Semester- 3

Reinforced Soil Structures			
Course Code	**22CGT31**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40 hours + 26 hours	Total Marks	100
Credits	04	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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
3. to attain the COs and POs

The sum of three 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. **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 limitations and strengthen the failed structures	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

Semester- 3

Earth Pressure and Earth Retaining Structures			
Course Code	**22CGT321**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
3. to attain the COs and POs

The sum of three 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.

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

Semester- 3

Earthquake Resistant design of Foundations			
Course Code	**22CGT322**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
3. to attain the COs and POs

The sum of three 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.

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

Semester- 3

Theory of Elasticity and Plasticity			
Course Code	**22CGT323**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the fundamentals of the continuum mechanics of solids
- Understand the failure criteria with focus on plasticity
- Understand the relationship between mechanical behaviour of solids and their underlying microstructure
- Enable students to select appropriate constitutive theory for finite element analysis.

Module-1	
ELASTICITY: Theory of Elasticity vs ordinary mechanics, concept of homogeneity, anisotropy, isotropy and orthotropy, generalized Hook's law, ideal stress – strain diagram for rigid, plastic and viscous materials. Numerical Problems	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-2	
PRINCIPAL STRESSES AND STRAINS: Notation for forces and stress components of stresses and strain, plane stress and plane strain, principal stress and strain, maximum shear stress, and shear planes, Mohr circle of stress and strain, strain rosettes Differential equations of equilibrium, boundary conditions, compatibility equations and stress functions. Numerical Problems	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-3	
PLANE STRESS AND PLANE STRAIN: Two-dimensional problems rectangular coordinates, displacement and deformation, St. Venant's and Prandtl's theories, determination of displacements Two-dimensional problems in polar coordinates – governing equations, stress distribution symmetric about axis. Numerical Problems	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-4	
THEORY OF PLASTICITY: Crystal Grains, mechanics of plastic deformation, consecutive stages of deformation: elastic and plastic deformation and fracture, inelastic deformation, factors affecting plastic deformation, strain hardening, stress-strain relationship, Tresca and VonMises criterion of yielding. Numerical Problems	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-5

Viscoelastic material: Maxwell body, Kelvin Voigt body, linear standard body Theories of failure: maximum principle stress theory, maximum principle strain theory, strain energy theory, distortion energy 8 Hours 18 theory, distortional energy, maximum shear stress theory. Numerical 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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
3. to attain the COs and POs

The sum of three 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. Theory of Elasticity – S Timoshenko and J N Goodier, McGraw Hill.
2. Theory of Elasticity – Sadhu Singh, Khanna Publication.
3. Applied Elasticity – T G Sitaram and L Govindaraju, Interline Publication, B.lore
4. Plasticity for Structural Engineers – Chen W F and Han D J (2000), SpringerVerlag
5. Engineering Plasticity – Slater R A C (1977), John Wiley and Sons, NY
6. Fundamentals of Plasticity – Kachanov (1974)

Reference Books:

1. Photo Elasticity - Frocht.
2. Mechanics of Materials – Hearn E J (1985), Pergamon Press, Oxford
3. Introduction to Solid Mechanics – Irving H Shames and James M Pitarresi, Prentice Hall of India
4. Theory of Plasticity – Chakrabarty (1987)

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/105/105105177/
- https://www.cet.edu.in/noticefiles/260_Lecturer%20Notes%20on%20AEP-ilovepdf-compressed.pdf
- https://onlinecourses.nptel.ac.in/noc20_ce42/preview

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Idealize the criteria governing the failure of soil in elastic and plastic states	L2, L5, L6
CO2	Provide better solutions to the problems of the soil related to deformation	L4, L5, L6

Mapping of COS and POs

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

Semester- 3

Offshore Geotechnical Engineering			
Course Code	**22CGT324**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

- Understand the type of soil strata available in offshore.
- Develop a structure under different environmental condition.
- Design the anchors in the sea.
- Design the pipelines and cable structures.

Module-1	
DESIGN OF OFFSHORE PLATFORMS: Introduction, fixed and floating platforms, case studies and general features, elements of hydrodynamics and wave theory, fluid structure interaction, steel concrete and hybrid platforms,Consolidation and shear strength characteristics of marine sediments	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-2	
Design Criteria: Environmental loading, wind, wave and current loads after installation, stability during towing Foundations: Site investigations, piled foundation, foundations for gravity structures, pile-supported structures	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-3	
Behaviour under dynamic loading, static and dynamic analysis of platforms and components	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-4	
Dynamic response in deterministic and indeterministic environment, codes of practice, analysis of fixed platform and semisubmersible related topics	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-5	
Anchor design, breakout resistance analysis and geotechnical aspects of offshore pipeline and cable design	
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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
3. to attain the COs and POs

The sum of three 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. **Offshore Geotechncial Engineering** – Mark Radolph and Susan Gourvenec, CRC Press.
2. **Construction of Marine and Offshore Structures** – Ben C Gerwick, CRC Press.
3. Offshore Geotechnical Engineering **– ETR Dean**

Reference Books:

1. **Frontiers in Offshore Geotechnics II** – Susan Gourvenec and David White, CRC Press.
2. **Frontiers in Offshore Geotechnics II**– Vaughan Meyer, CRC Press
3. **Geotechnical Aspects of Coastal and Offshore Structures: Proceedings of the Symposium, Bangkok–** A S Balasubramaniam, CRC Press

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/114/106/114106015/
- https://nptel.ac.in/courses/114106011
- https://onlinecourses.nptel.ac.in/noc21_oe01/preview

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Design the structure for wind, wave loads and dynamic loads.	L2, L5
CO2	Design the structure for overturning.	L5
CO3	Design the pipeline and cable structures.	L5

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

Semester- 3

FORENSIC GEOTECHNICAL ENGINEERING			
Course Code	**22CGT325**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

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. 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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
3. to attain the COs and POs

The sum of three 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.

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

Semester- 3

Geotechnical Practice for Waste Management System and Ground modifications			
Course Code	**22CGT331**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	50
Total Hours of Pedagogy	04	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students to

- Contamination in soils and causes for contamination
- Use of soil liners in the landfill
- Understand the mechanical modifications of the soil

Module-1

Introduction to waste containment, Soil system and soil-water pollution interaction, Structural components of clayey soils for landfill liner, Soil organic matter-soil minerals interaction Site investigation at polluted sites (Geophysical techniques, Hydrological investigations etc.)

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

Module-2

Landfill liner system, Classification of liners and potential problems for clay barrier system, Leachate & gas collection and removal system, Leachate production and clay-leachate compatibility

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

Module-3

Soil attenuation by biochemical, physical & chemical processes, Final covering system, Design of top & drainage layers, Monitoring in the saturated and unsaturated zone, Construction quality control and quality assessment, Challenges associated with landfill design & construction in tropical region

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

Module-4

Mechanical modification: Introduction, principles of soil densification, properties of compacted soil and compaction control specifications for quality controls. Hydraulic modification: Introduction, objectives, techniques, Dewatering methods, soil and water relationship, Types of aquifer, Design of Dewatering systems, filtration, drainage and seepage, control, preloading and vertical drains, electro kinetic dewatering and stabilization.

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

Module-5

Ground Modifications: Physical and chemical Modification: Modification by admixtures, grouting, and thermal modification. Modification by inclusions and confinement: Soil reinforcement, ground

anchorage, and rock bolting soil nailing, crib walls, and gabions	
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:

4. Three Unit Tests each of **20 Marks**
5. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
6. to attain the COs and POs

The sum of three 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:

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

Suggested Learning Resources:

Text Books:

1. Geoenvironmental Engineering- Principles and Applications (2004): L.N. Reddy & H.F. Inyang, Marcel Dekkar
2. Geotechnical Practice for Waste Disposal (1993): D.E. Daniel Chapman and Hall, London.
3. Construction and Monitoring of Landfills (1994). A. Bagchi, John Wiley and Pone N.Y.,

Reference Books:

1. Geotechnical Engineering(2002): D.P. Coduto, Pearson Education Asia
2. Engineering Principles of Ground Modification(1990), Hausmann, M.R., McGraw-Hill International Editions
3. Ground Control and Improvement(1994), Xanthakos, P.P., Abramson, L.W. and Bruce, D.A John Wiley & Son

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=RQ70G1uQwe8
- https://gec.digimat.in/nptel/courses/video/105108075/L40.html
- http://www.digimat.in/nptel/courses/video/105108075/L38.html

Skill Development Activities Suggested

- Model exhibition
- Workshops and seminars
- Industrial visits to observe landfills

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Contamination in soils and causes for contamination	L5
CO2	Use of soil liners in the landfill	L3, L4
CO3	Understand the mechanical modifications of the soil	L3, L4, L5

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

Mapping of COS and POs

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

Semester- 3

Remote Sensing and Geographic Information System			
Course Code	**22CGT332**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the basic concepts of remote sensing.
- Analyze satellite imagery and extract the required units.
- Extract the GIS data and prepare the thematic maps.
- Use the thematic camps for various applications.

Module-1

Remote Sensing: Basic concept of Remote sensing, Data and Information, Remote sensing data collection, Remote sensing advantages & Limitations, Remote Sensing process. Electromagnetic Spectrum, Energy interactions with atmosphere and with earth surface features (soil, water, and vegetation), Resolution, image registration and Image and False color composite, elements of visual interpretation techniques.

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

Module-2

Remote Sensing Platforms and Sensors: Indian Satellites and Sensors characteristics, Remote Sensing Platforms, Sensors and Properties of Digital Data, Data Formats: Introduction, platforms- IRS, Landsat, SPOT, Cartosat, Ikonos, Envisat etc. sensors, sensor resolutions (spatial, spectral, radiometric and temporal). Basics of digital image processing- introduction to digital data,

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

Module-3

Geographic Information System: Introduction to GIS; components of a GIS; Geographically Referenced Data, Spatial Data- Attribute data-Joining Spatial and attribute data, GIS Operations: Spatial Data Input – Attribute data Management, Geographic coordinate System, Datum; Map Projections: Types of Map Projections, Projected coordinate Systems. UTM Zones.

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

Module-4

Data Models: Vector data model: Representation of simple features – Topology and its importance; coverage and its data structure, Shape file; Relational Database, Raster Data Model: Elements of the Raster data model, Types of Raster Data, Raster Data Structure, and Data conversion.

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

Module-5

Integrated Applications of Remote sensing and GIS: Applications in land use land cover analysis, change detection, water resources, urban planning, environmental planning, Natural resource management and Traffic management. Location Based Services And Its Applications.

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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
3. to attain the COs and POs

The sum of three 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:

- Narayan Panigrahi, "Geographical Information Science", and ISBN 10: 8173716285 / ISBN 13: 9788173716287, University Press 2008.
- Basudeb Bhatta, "Remote sensing and GIS" , ISBN:9780198072393, Oxford University Press 2011
- Kang – Tsurg Chang, "Introduction to Geographic Information System". Tata McGraw Hill Education Private Limited 2015. Lillesand, Kiefer, Chipman, "Remote Sensing and Image Interpretation", Wiley 2011.

Reference Books:

- Chor Pang Lo and Albert K.W Yeung, "Concepts & Techniques of GIS", PHI, 2006
- John R. Jensen, "Remote sensing of the environment", An earth resources perspective – 2nd edition – by Pearson Education 2007.
- Anji Reddy M., "Remote sensing and Geograperhical information system", B.S. Publications 2008.
- Peter A. Burrough, Rachael A. McDonnell, and Christopher D. Lloyd, "Principals of Geo physical Information system", Oxford Publications 2004.

- S Kumar, “Basics of remote sensing & GIS”, Laxmi publications 2005.

Web links and Video Lectures (e-Resources):

- https://www.digimat.in/nptel/courses/video/105101206/L01.html
- https://www.digimat.in/nptel/courses/video/105107201/L01.html
- https://www.costelloinc.com/blog/remote-sensing-applications-in-gis#:~:text=Remote%20sensing%20is%20one%20of,mounted%20on%20satellites%20or%20aircraft.
- https://nptel.ac.in/courses/107105088
- https://nptel.ac.in/courses/105103193

Skill Development Activities Suggested

- using GIS software’s
- visiting GIS stations
- workshops and guest lectures

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Collect data and delineate various elements from the satellite imagery using their spectral signature.	L1, L2
CO2	Analyze different features of ground information to create raster or vector data.	L2, L4
CO3	Perform digital classification and create different thematic maps for solving specific problems	L2, L5
CO4	Make decisions based on the GIS analysis on thematic maps.	L5

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

Mapping of COS and POs

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

Semester- 3

UnsaturatedSoil Mechanics			
Course Code	**22CGT333**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	50
Total Hours of Pedagogy		Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand concept of shear stress and its importance.
- Know the behavior hydraulic conductivity of the soil.
- Know the importance of soil-water interaction in applied soil engineering.

Module-1

Module -1

Introduction to Unsaturated Soil Mechanics: Types of problems, typical profiles of unsaturated, tropical and residual soil, expansive and collapsing type of soils. Origin and formation, identification and classification of expansive and collapsing soils, Contractile skin.

Collapse and Heave: Collapse potential and swell potential, importance and their determination by different laboratory methods, Heave prediction based on oedometer tests, suction tests and empirical procedures, heave and collapse settlement

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

Module-2

Soil Suction: Matric and osmotic suction, total suction, theory of soil suction, measurement by direct and indirect methods – Tensiometers, Axis translation technique, Pressure plate apparatus, Filter paper method, Psychrometers, Squeezing technique of measuring osmotic suction

Flow through unsaturated soils – flow laws, Darcy's law for unsaturated soils, coefficient of permeability with respect to water phase and air phase, air diffusion, measurement of permeability and air coefficient of

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

Module-3

Phase properties and relations for unsaturated soils: Properties of individual phases, interaction of air and water, volume-mass relations, changes in volume-mass properties, densities of mixtures subjected to compression of the air phase, piston porous stone analogy, effective stress concepts and stress state variables for unsaturated soils, equilibrium analysis for unsaturated soils: total or overall equilibrium, independent phase equilibrium – water phase, air phase, contractile skin(meniscus)

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

Module-4

Design alternatives for structures on expansive soils: Structural foundation alternatives, treatment of expansive soils – general considerations and guidelines, surcharge loading, prewetting, use of admixtures, electrochemical soil treatment, moisture control and soil stabilization, treatment alternatives for highways and airfield pavements.

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

Module-5

Shear strength: History of shear strength, failure envelope for unsaturated soils, use of effective stress parameters to define shear strength, Mohr-coulomb and stress points envelopes, triaxial tests on unsaturated soils, CD tests, constant water content tests, CU tests with pore pressure measurements, undrained tests, multistage testing, measurement of shear strength parameters

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:

4. Three Unit Tests each of **20 Marks**
5. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
6. to attain the COs and POs

The sum of three 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:

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

Suggested Learning Resources:

Text Books:

1. **Soil Mechanics for Unsaturated Soils** – DG Fredlund and H Rahardjo, Wiley Interscience Publication, John Wiley & Sons, NY
2. **Unsaturated Soil Mechanics** – Ning Lu and William J Likos, John Wiley & Sons, INC

Reference Books:

1. **Mechanics of Residual Soils** – G E Blight, A ABalkema Publishers, USA
2. **Expansive Soils – Problems & Practice in Foundations and Pavement Engineering** – John D Nelson and Debora J Miller, John Wiley & Sons, NY

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105103177
- https://www.youtube.com/watch?v=IP94-4XDBsI
- http://virtualuniversity.issmge.org/courses/course-v1:Delwyn-G-Fredlund+Unsaturated-Soil-Mechanics+2019/courseware/19c80350334f416ebd8eebe89b8a8cdd/35bb9fdcefcc40299a20b

Skill Development Activities Suggested

- Expert talk and guest lectures

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand concept of shear stress and its importance.	L2, L4
CO2	Know the behavior hydraulic conductivity of the soil.	L4
CO3	Know the importance of soil-water interaction in applied soil engineering.	L2, L4, L5

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

Mapping of COS and POs

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

Semester- 3

Construction Safety and Management			
Course Code	**22CGT334**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	4::0:0	SEE Marks	50
Total Hours of Pedagogy		Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the elements of quality planning and the implication.
- Become aware of objectives and advantage of quality assurance.
- Study the relationship between quality and safety management

Module-1	
Construction Quality Management- need and importance, Quality control and methods, Quality Assurance, Quality assurance plan, Inspection and Testing- Process, Inspection test report, concepts of quality policy, Quality standards, Quality manual	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-2	
Quality Certification for companies and laboratories (ISO Certification, NABL certification). Total Quality Management, Features and Elements of TQM, Critical factors of TQM, TQM in construction Projects. Benchmarking, Types of Benchmarking and process, Third Party Certification- Process involved.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-3	
Construction Safety-meaning and scope, Safety in construction Technological aspects, organizational aspects and behavioural aspects, Safety in Project management, Education and training. Safety legislation and Standards, Contract conditions on safety in Civil Engineering projects.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-4	
Safety in Construction: Causes, classification, cost and measurement of an accident, safety programme for construction, protective equipment, accident report, safety measure: (a) For storage and handling of building materials. (b) Construction of elements of a building (c) In demolition of buildings Safety lacuna in Indian scenario	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-5
Types of injuries, Factors affecting safety, Strategic Planning for safety provisions. Personal & Structural safety - Safety consideration during construction, demolition and during use of equipment. Recording injuries and accident indices. Method statement, SOPs, PPE, Inspections, Investigations.

Site safety programmes - JSA, JHA, Root cause analysis, meetings, safety policy, manuals, training & orientation.	
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. Three Unit Tests each of 20 Marks
2. Two assignments each of 20 MarksoroneSkill Development Activity of 40 marks
3. to attain the COs and POs

The sum of three 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.

Suggested Learning Resources:

Textbooks:

- N. Logothetis, "Management for Total Quality", Prentice Hall
- David Gold Smith, "Safety Management in construction and Industry", Mc Graw Hill
- K N Vaid, "Construction Safety Management", NICMAR, Bombay
- D S Rajendra Prasad, "Quality Management System in Civil Engineering", Sapna Book House, Bangalore

Reference books:

- "The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996, Universal Law Publishing Co. Pvt. Ltd.
- Robert (QMP) " Bench Marking", " The search for industry Best Practices that led to superior performance" American Society of Quality 1995
- Break Joseph and Susan Joseph " Total Quality Management", Excel Books , New Delhi, 1995.
- Juran Frank, J.M. and Gryna, F.M. "Quality Planning and Analysis", Tata McGraw Hill 2002.
- James, J.O Brian, "Construction Inspection Handbook –Quality" 2009

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/102/105102206/
- https://irefglobal.com/courses/certificate-in-construction-quality-safety/
- https://www.coursera.org/lecture/construction-project-management/safety-in-construction-industry-nIAmE
- https://www.youtube.com/watch?v=ypTiYyh7YT0

Skill Development Activities Suggested

- Learning management software's
- Visiting sites for Safety instructions and safety management works

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Can be exposed to means of quality control.	L2, L5
CO2	Can be able to taken safety measures in construction	L3, L4, L5

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

Mapping of COS and POs

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

Semester- 3

Theoretical Soil Mechanics			
Course Code	**22CGT335**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To impart the knowledge for computation of settlements and stress in semiinfinite elastic soil medium
- Settlements and stress in anisotropic medium and layered deposits due to foundation loads
- Concept on plastic collapse.

Module-1

Introduction – Elasticity and stability problems, concept of stress and strain – plane stress, plane strain and axisymmetric problems – equation of equilibrium and compatibility – stress functions.

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

Learning Process	
Module-2	
Stresses in elastic half-space medium by external loads – fundamental solutions –Boussinesq, Flamant, Kelvin and Mindlin solution – Applications of fundamental solutions – Anisotropic and non-homogeneous linear continuum – Influence charts - elastic displacement-layered soil-Burmister method	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-3	
Limit equilibrium analysis – perfectly plastic material – stress – strain relationship –stress and displacement field calculations – slip line solutions for undrained and drained loading, arching of soils and theories of arching	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-4	
Limit analysis – principles of virtual work – theorems of plastic collapse – Mechanism for plane plastic collapse – Simple solutions for drained and undrained loading –stability of slopes, cuts and retaining structures. Centrifuge model – Principles and scale effects, practical considerations	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving
Module-5	
Flow through porous media – Darcy's law – General equation of flow – steady state condition – solution by flow net – fully saturated conditions; Yielding, Bounding Surfaces	
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. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**
3. to attain the COs and POs

The sum of three 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.

Suggested Learning Resources:

Textbooks:

1. Foundations of Theoretical Soil Mechanics, Harr, M.E (1966) McGraw Hill,

2. Foundation Engineering Handbook, Winterkorn, H.F., and Fang, H.Y(2000) Galgotia, Booksource, 2000

3. Theoretical Soil Mechanics- Karl Terzaghi (1943), John Wiley & Sons.

4. Soil Mechanics and Foundations, MuniramBudhu(2007), John Wiley & Sons, Inc.

Reference Books:

1. Soil Mechanics, T.W. Lambe and R.V. Whitman (1969). John Wiley &Sons,.
2. Foundations and slopes- Attikinson (1981), McGraw Hill, New Delhi
3. Seepage, Drainage and Flownets – Cedergren H R(1997).-, John Wiely& Sons
4. The Mechanics Basic concepts and Engineering Applications- Aysen A (2002), AA Balkema Publishers, 2002

Web links and Video Lectures (e-Resources):

- https://www.geoengineer.org/education/soil-mechanics
- https://www.youtube.com/watch?v=3a-nAkxJmm8
- https://www.youtube.com/watch?v=szI839XV758

Skill Development Activities Suggested

- Online courses

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	To impart the knowledge for computation of settlements and stress in semiinfinite elastic soil medium	L4, L5
CO2	Settlements and stress in anisotropic medium and layered deposits due to foundation loads	L2, L3
CO3	Concept on plastic collapse.	L4, L5
CO4		

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

Mapping of COS and POs

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

Semester III

PROJECT WORK PHASE – 1			
Course Code	22CGT34	CIE Marks	100
Number of contact Hours/Week	00:06:00	SEE Marks	--
Credits	03	Exam Hours	--

Course objectives:

- Support independentlearning.
- Guide to select and utilize adequate information from varied resources maintainingethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentationskills.
- Impart flexibility andadaptability.
- Inspire independent and teamworking.
- Expand intellectual capacity, credibility, judgement,intuition.
- Adhere to punctuality, setting and meetingdeadlines.
- Instil responsibilities to oneself andothers.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchangeideas.

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power pointslides.
- Answer the queries and involve indebate/discussion.
- Submit two copies of the typed report with a list ofreferences.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

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

- Demonstrate a sound technical knowledge of their selected projecttopic.
- Undertake problem identification, formulation, andsolution.
- Design engineering solutions to complex problems utilising a systemsapproach.
- Communicate with engineers and the community at large in written an oralforms.
- Demonstrate the knowledge, skills and attitudes of a professionalengineer.

SOCIETAL PROJECT			
Course Code	22CGT35	CIE Marks	100
Number of contact Hours/Week	00:06:00	SEE Marks	--
Credits	03	Exam Hours	--

Course objectives:

- Support independentlearning.
- Guide to select and utilize adequate information from varied resources maintainingethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentationskills.
- Impart flexibility andadaptability.
- Inspire independent and teamworking.
- Expand intellectual capacity, credibility, judgement,intuition.
- Adhere to punctuality, setting and meetingdeadlines.
- Instil responsibilities to oneself andothers.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchangeideas.

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the societal Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected societal project orally and/or through power pointslides.
- Answer the queries and involve indebate/discussion.
- Submit two copies of the typed report with a list ofreferences.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

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

- Demonstrate a sound technical knowledge of their selected societal projecttopic.
- Undertake problem identification, formulation, andsolution.
- Design engineering solutions to complex problems utilising a systemsapproach.
- Communicate with engineers and the community at large in written an oralforms.
- Demonstrate the knowledge, skills and attitudes of a professionalengineer.

Semester III

INTERNSHIP			
Course Code	22CGTI36	CIE Marks	50
Number of contact Hours	06 Weeks	SEE Marks	50
Credits	06	Exam Hours	03

Course objectives:

Internship provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

- To put theory intopractice.
- To expand thinking and broaden the knowledge and skills acquired through course work in thefield.
- To relate to, interact with, and learn from current professionals in thefield.
- To gain a greater understanding of the duties and responsibilities of aprofessional.
- To understand and adhere to professional standards in thefield.
- To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, andconfidentiality.
- To identify personal strengths andweaknesses.
- To develop the initiative and motivation to be a self-starter and workindependently.

Internship/Professional practice: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power pointslides.
- Answer the queries and involve indebate/discussion.
- Submit the report duly certified by the externalguide.
- The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and becomeself-confident.

Course outcomes:

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

- Gain practical experience within industry in which the internship isdone.
- Acquire knowledge of the industry in which the internship isdone.
- Apply knowledge and skills learned to classroomwork.
- Develop a greater understanding about career options while more clearly defining personal careergoals.
- Experience the activities and functions ofprofessionals.
- Develop and refine oral and written communicationskills.
- Identify areas for future knowledge and skilldevelopment.
- Expand intellectual capacity, credibility, judgment,intuition.
- Acquire the knowledge of administration, marketing, finance andeconomics.

Semester III

PROJECT WORK PHASE -2			
Course Code	22CGT41	CIE Marks	100
Number of contact Hours/Week(L:P:S)	00:08:00	SEE Marks	100
Credits	18	Exam Hours	03

Course objectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintainingethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentationskills.
- To impart flexibility andadaptability.
- To inspire independent and teamworking.
- To expand intellectual capacity, credibility, judgement,intuition.
- To adhere to punctuality, setting and meetingdeadlines.
- To instil responsibilities to oneself andothers.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchangeideas.

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes:

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

- Present the project and be able to defendit.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the projecttask.
- Habituated to critical thinking and use problem solvingskills
- Communicate effectively and to present ideas clearly and coherently in both the written and oralforms.
- Work in a team to achieve commongoal.
- Learn on their own, reflect on their learning and take appropriate actions to improveit.