Curriculum and Syllabus for M. Tech in Geotechnical Engineering

L-Lecture; T-Tutorial; P-Practical

1st Semester							
Course Code	Paper Code	Subject Name	Contact Hours / Week				Credit Points
			L	T	P	Total	
A: THEORY:							
PC	GTE 101	Advanced Mechanics of Soil and Rock	3	1	0	4	4
PC	GTE 102	Advanced Foundation Engineering-I	3	1	0	4	4
PE-1	GTE 103	A. Soil Structure Interaction B. Ground Improvement Techniques C. Transportation Geo Techniques	3	1	0	4	4
PE-2	GTE 104	A. Underground construction and Tunnelling B. Slope Stability and Earthen Dam C. Instrumentation in Geotechnical Engineering	3	1	0	4	4
IPR		Research Methodology and IPR	2	0	0	2	2
AUDIT1		English for Research Paper Writing	1	0	0	1	0
B: LABORATORY:							
Core Lab-I	GTE 191	Geotechnical Laboratory -I	0	0	2	2	2
Core Lab-II	GTE 192	Computer Application in Geotechnical Engineering - Laboratory	0	0	2	2	2
Total of Theory & Practical							22

2nd Semester							
Course Code	Subject Code	Subject Name	Contact Hours / Week				Credit Points
			L	T	P	Total	
A: THEORY:							
PC	GTE201	Advanced Foundation Engineering- II	3	1	0	4	4
PC	GTE202	Subsoil Investigation	3	1	0	4	4
PE-3	GTE203	A. Advanced Ground Improvement Techniques B. Retaining Structures and Coffer Dam C. Offshore Structures	3	1	0	4	4
PE-4	GTE204	A. Soil Dynamics and Machine Foundation. B. Advanced Ground Water Hydrology. C. Geosynthetics Engineering	3	1	0	4	4
AUDIT2		Disaster Management	1	0	0	1	0
B: LABORATORY:							
Core Lab-III	GTE291	Geotechnical Lab- II	0	0	2	2	2
Core Lab-IV	GTE292	Preparation of geotechnical report	0	0	2	2	2
C: SESSIONAL							
PROJECT & SEMINAR	GTE281	Mini Project with Seminar	0	0	0	2	2
Total of Theory, Practical & Sessional							22

3rd Semester							
Course Code	Subject Code	Subject Name	Contact Hours / Week				Credit Points
			L	T	P	Total	
A: THEORY:							
PE	GTE301	A. Geotechnical Earthquake Engineering B. Remote Sensing and its application in Geo Technical Engineering C. Reinforced Earth	3	1	0	4	4
OE	GTE302	A. Industrial Safety B. Operations Research C. Cost Management of Engineering Projects D. Waste to Energy	3	1	0	4	4
C: SESSIONAL							
Thesis/ Dissertation	GTE381	Dissertation- Stage I	0	0	24	24	12
Total of Theory, Practical & Sessional							20

4th Semester							
Course Code	Subject Code	Subject Name	Contact Hours / Week				Credit Points
			L	T	P	Total	
C: SESSIONAL							
Thesis/ Dissertation	GTE481	Dissertation- Stage II - Final (Continued from Semester-3)	0	0	32	32	16
Thesis/ Dissertation	GTE482	Comprehensive Exam (Viva-Voce)	0	0	0	0	6
Total of Theory, Practical & Sessional							22

TOTAL CREDIT = 86

1st Semester							
Course Code	Paper Code	Subject Name	Contact Hours / Week				Credit Points
			L	T	P	Total	
A: THEORY:							
PC	GTE 101	Advanced Mechanics of Soil and Rock	3	1	0	4	4
PC	GTE 102	Advanced Foundation Engineering-I	3	1	0	4	4
PE-1	GTE 103	D. Soil Structure Interaction E. Ground Improvement Techniques F. Transportation Geo Techniques	3	1	0	4	4
PE-2	GTE 104	D. Underground construction and Tunnelling E. Slope Stability and Earthen Dam F. Instrumentation in Geotechnical Engineering	3	1	0	4	4
IPR		Research Methodology and IPR	2	0	0	2	2
AUDIT1		English for Research Paper Writing	1	0	0	1	0
B: LABORATORY:							
Core Lab-I	GTE 191	Geotechnical Laboratory -I	0	0	2	2	2
Core Lab-II	GTE 192	Computer Application in Geotechnical Engineering - LAB	0	0	2	2	2
Total of Theory & Practical							22

Syllabus-1st Semester

ADVANCED MECHANICS OF SOIL AND ROCK

(CODE: GTE 101)
TOTAL CONTACT HOURS: 48
CREDIT:4

Course Outcomes:
Students will be able to:
CO1: Apply the theory of consolidation and its related parameters to estimate the settlement of foundation
CO2: Utilize shear strength parameters and its related characteristics to predict behavior of soil
CO3: Analyze the stability of slopes for different geotechnical applications.
CO4: Analyze lateral earth pressure by different methods for *design* of retaining wall and sheet pile structures
CO5: Classify rock mass characteristics by laboratory and in- situ tests

Course Contents

Module 1: One- and three-dimensional consolidation theories and applications, Immediate settlement, Methods of determination, Estimation of Pre-consolidation pressure, Secondary consolidation.	8L
Module 2: Shear strength parameters of cohesion less and saturated cohesive soils, Principles of Effective stress condition, Effect of rate of stress on shear parameters, Stress- Strain relationship, Skempton's Pore pressure coefficients, Hvorslev's true shear parameters, Effect of over consolidation on shear parameters.	10L
Module 3: Stability analysis of slope -effective vs. total stress analysis, Stability Analysis of Slope: Effective and total stress approach, shape of slip surface, methods of slices, graphic methods, location of critical slip circle, wedge analysis method, stability during critical conditions.	10L
Module 4: Earth pressure – Rankine, Coulomb and Graphical Methods, retaining walls structures, Gravity cantilever and counter fort retaining walls: Stability checks and design: Sheet Pile Structures: Cantilever sheet piling, Anchored sheet piling: Free and fixed earth support methods of Analysis, Braced excavations.	12L
Module 5: Classification and characterisation of rock mass, in-situ determination of engineering properties of rock mass, in-situ stresses.	8L

Text / Reference Books:

1. B M Das, *Advanced Soil Mechanics*, Taylor and Francis
2. R F Scott, *Principles of Soil Mechanics*, Addison & Wesley.
3. R.O. Davis and A.P.S. Selvadurai, *Elasticity and Geomechanics*, Cambridge University Press, New York.
4. Mitchell, James K, *Fundamentals of Soil Behaviour*, John Wiley and Sons
5. D.M. Wood, *Soil Behaviour and Critical State Soil Mechanics,* University of Glasgow

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	2
CO2	3	3	2	3	2	2
CO3	3	3	2	3	2	2
CO4	3	3	2	3	2	2
CO5	3	3	2	3	2	2

ADVANCED FOUNDATION ENGINEERING-I
(CODE: GTE 102)
TOTAL CONTACT HOURS: 48
CREDIT:4

Course Outcomes:
Students will be able to:
CO1: Apply bearing capacity theories and stress distribution methods for analysis of shallow foundation
CO2: Evaluate foundation settlement in homogeneous and stratified soil layers
CO3: Evaluate bearing capacity from different field test data.
CO4: Analyze foundation on problematic soil and apply different remedial measures for such foundations

Course Contents

Module-1: Shallow Foundation: Terzaghi's bearing capacity equation, General bearing capacity equation, different bearing capacity theories, I.S. Code method, Effect of foundation shape, eccentricity and inclination of load, Influence of soil compressibility and water table, Footing pressure for settlement on sand, Soil pressure at a depth, Boussinesq's & Westergaard methods.	14L
Module-2: Raft Foundation: Settlement and Bearing Capacity analysis, Analysis of flexible and rigid raft as per IS 2950. Computation of settlements (Immediate & Consolidation); Permissible settlements, Allowable total and differential settlement of structures.	14L
Module-3: Proportioning of footing, Inclined & Eccentric loads. Settlement of footings on stratified deposits. Influence of adjacent footings.	10L
Module-4: Bearing Capacity from SPT and SCPT and Plate load Test data, Foundations on Problematic soils: Problems and Remedies.	10L

Text / Reference Books:

1. B. M Das, *Principles of Foundation Engineering*, Thomson Brooks/Cole
2. J. E. Bowles, *Foundation Analysis and Design*, McGraw-Hill Book Company
3. N.P. Kurien, *Design of Foundation Systems: Principles & Practices*, Narosa, New Delhi 1992
4. H. F. Winterkorn and H Y Fang, *Foundation Engineering Hand Book*, Galgotia Booksource

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	2
CO2	3	3	2	3	2	2
CO3	3	3	2	3	2	2
CO4	3	3	2	3	2	2

SOIL STRUCTURE INTERACTION
(CODE: GTE 103A)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT:4

Course Outcomes:

Students will be able to:

CO1: Analyse soil-structure interaction problems considering soil behaviour using appropriate soil response models.

CO2: Solve soil-structure interaction problems using the theory of beams on elastic foundation.

CO3: Evaluate the behaviour of plates on elastic medium for application in soil-structure interaction problems.

CO4: Analyse single pile and pile group behaviour for predicting settlement and load distribution in soil-structure interaction problems.

Course Contents

Module 1: General soil-structure interaction problems: Contact pressures and soil-structure interaction for shallow foundations, concept of sub grade modulus, effects/parameters influencing subgrade modulus. Soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models	12L
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.	12L
Module 3: Plate on Elastic Medium: Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions.	10L
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. Laterally Loaded Pile: Load deflection prediction for laterally loaded piles, Sub-grade reaction and elastic analysis, Interaction analysis.	14L

Text / Reference Books:

1) Selva durai, A. P. S, Elastic Analysis of Soil-Foundation Interaction, Elsevier,1979.
2) Poulos, H. G., and Davis, E. H.,Pile Foundation Analysis and Design, John Wiley,1980.
3) Scott, R. F., Foundation Analysis, Prentice Hall, 1981.
4) Structure Soil Interaction - State of Art Report, Institution of Structural Engineers, 1978.
5) ACI 336. (1988), Suggested Analysis and Design Procedures for combined footings and Mats, American Concrete Institute, 1988.

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	2
CO2	3	3	2	3	2	2
CO3	3	3	2	3	2	2
CO4	3	3	2	3	2	2

GROUND IMPROVEMENT TECHNIQUES
(CODE: GTE 103B)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT:4

Course Outcomes:

Students will be able to:

CO1: Understand the need for ground improvement and classify various ground improvement methods for different soil conditions.

CO2: Analyze and solve problems related to mechanical and chemical modification techniques, including compaction, stone columns, and soil stabilization methods.

CO3: Apply the different procedures of Chemical modifications.

CO4: Able to apply the reinforcement techniques to select suitable ground improvement methods.

Course Contents

Module 1: Introduction to Ground Improvement: Need of ground improvement, different methods of ground improvement.	4L
Module 2: Mechanical Modification: General principles of compaction, quality control in the field, dynamic compaction, impact loading, compaction by blasting, vibro-compaction, preloading methods, types of drains – design of vertical drains, construction techniques, stone column – design principles, construction techniques, settlement of stone column foundation.	16L
Module 3: Chemical Modification: Lime stabilization, cement stabilization, fly–ash–lime stabilization, bitumen stabilization, modification by admixtures, stabilization using industrial wastes, grouting, types of grout, desirable characteristics, grouting pressure, grouting methods.	16L
Module 4: Soil Reinforcement: Reinforced earth, reinforcement-soil interaction, types of reinforcements, geosynthetics and their application and soil nailing.	12L

Text / Reference Books:

1. R. M. Korner, *Design with Geosynthetics*, Prentice Hall, New Jersy, 3rd Edn. 2002
2. P. Purushothama Raj, *Ground Improvement Techniques*, Tata McGrawHill, New Delhi, 1995.
3. Dr. B.C.Chattopadhyay and J.Maity, *Ground Improvement Techniques*, PHI Learning, 2011.
4. G. V. Rao and G. V. S. Rao, *Text Book On Engineering with Geotextiles*, Tata McGraw Hill
5. T. S. Ingold and K. S. Miller, *Geotextile Hand Book*, Thomas Telfrod, London
6. N. V. Nayak, *Foundation Design Manual*, Dhanpat Rai and Sons, Delhi.
7. M.P.Moasley, *Ground Improvement Techniques*

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	1	3	2	2
CO2	3	3	2	3	3	2
CO3	3	3	2	3	3	2
CO4	3	3	2	3	3	3

TRANSPORTATION GEOTECHNIQUES
(CODE: GTE 103C)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT:4

Course Outcomes:

Students will be able to:

CO1: Understand the fundamental principles and philosophy behind the design of flexible and rigid pavements.

CO2: Analyze pavement performance using different analytical methods and evaluate the effects of traffic loading, material properties, and environmental conditions.

CO3: Develop pavement design solutions, including flexible, rigid, while considering drainage and failure criteria.

CO4: Able to compare various pavement design approaches and select appropriate methods for practical transportation engineering projects with design of overlay and drainage systems.

Course Contents

Module I: Philosophy of design of flexible and rigid pavements.	8L
Module II: Analysis of pavements using different analytical methods,	12L
Module III: Selection of pavement design input parameters – traffic loading and volume. Material characterization, drainage, failure criteria, and reliability. Design of flexible and rigid pavements using different methods.	18L
Module IV: Comparison of different pavement design approaches, design of overlays and drainage system.	10L

Text / Reference Books:

Yang and H. Huang, Pavement Analysis and Design, Pearson Prentice Hall, 2004.
Yoder and Witzech, Pavement Design, McGraw-Hill, 1982.
Sharma and Sharma, Principles and Practice of Highway Engg., Asia Publishing House, 1980.
Teng, Functional Designing of Pavements, McGraw- Hill, 1980.

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	1	3	2	2
CO2	3	3	2	3	3	2
CO3	3	3	2	3	3	2
CO4	3	3	2	3	3	3

UNDERGROUND CONSTRUCTION AND TUNELLING
(CODE: GTE 104A)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT:4

Course Outcomes:

Students will be able to:

CO1: Apply the principles of braced excavation, earth pressure, wall support design, and the sequence of underground construction activities.

CO2: Analyze the behaviour of tunnels, shafts, and underground openings, including pressure distribution, ground loss, and structural geology effects.

CO3: Develop design solutions for rock tunnelling, rock slopes, and rock foundations.

CO4: Able to apply bearing capacity formulation for rock, incorporating drilling, blasting, and grouting techniques.

Course Contents

Module 1: Braced excavation, types, earth pressure, effect of wall rigidity and sequence of construction, Design of wall and wall supports.	6L
Module 2: tunnels and shafts, pressure distribution, design of tunnel lining, methods of tunnelling, ground loss, Underground openings.	16L
Module 3: Structural geology in rock tunnelling, Rock slopes, Rock foundations.	12L
Module 4: Bearing Capacity of Rocks; Drilling and blasting of rocks; Grouting; Instrumentation and measurements in tunnelling.	14L

Text / Reference Books:

Sl. No.	Author(s)	Book Title	Publisher
1	Bickel, J.O., Kuesel, T.R., & King, E.H.	*Tunnel Engineering Handbook*	Springer
2	Singh, B., & Goel, R.K.	*Tunnelling in Weak Rocks*	Elsevier
3	Harrin, R.	*Tunnel Boring Machines: Trends and Developments*	CRC Press
4	Chapman, D.N., Metje, N., & Stärk, A.	*Introduction to Tunnel Construction*	CRC Press

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	1	3	2	2
CO2	3	3	2	3	3	2
CO3	3	3	2	3	3	3
CO4	3	3	2	3	3	3

SLOPE STABILITY AND EARTHEN DAM
(CODE: GTE 104B)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT:4

Course Outcomes:

Students will be able to:

CO1: Apply the principles of total and effective stress analysis and the stability of earth and rock-fill dams.

CO2: Analyze seepage behavior under steady-state, rapid drawdown, conditions.

CO3: Apply design solutions for earth dams, incorporating stability, drainage, and construction stage considerations.

CO4: Able to apply principles of seismic analysis of embankments and assess reinforced slope stability under dynamic loading conditions.

Course Contents

Module 1: Total and Effective stress analysis; Stability of earth and rock fill dams.	8L
Module 2: Steady state seepage and rapid drawdown cases.	10L
Module 3: Design of earth dams; Pore pressure during construction stage; Methods of seepage control in earth dams.	14L
Module 4: Seismic analysis of embankment. Analysis of reinforced slope.	16L

Text / Reference Books:

1) Embankment Dam Engineering - Bharat sing, R.S.– 1 January 2004 by R.S.Varshney (Author), Bharat Singh (Author)
2) Concrete Dams, Earth and Rock-fill Dams by Varshney R.S., Oxford & IBH publisher

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	1	3	2	2
CO2	3	3	2	3	3	2
CO3	3	3	2	3	3	3
CO4	3	3	2	3	3	3

INSTRUMENTATION IN GEOTECHNICAL ENGINEERING
(CODE: GTE 104C)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT:4

Course Outcomes:

Students will be able to:

CO1: Understand the principles of geotechnical instrumentation and the use of settlement gauges, piezometers, earth pressure cells, inclinometers, and vibration measurement devices.

CO2: Apply field measurements and data collection from underground construction and tunnelling.

CO3: Develop instrumentation plans and monitoring strategies for geotechnical projects of dams and embankments.

CO4: Able to investigate geotechnical failures using case histories and interpret instrumentation data for design improvements and risk mitigation.

Course Contents

Module 1: Types of field measurements; Principles of instrumentation; Settlement gauges, Piezometers, earth pressure cells and inclinometers; Planning of instrumentation; Vibration measurements.	16L
Module 2: Instrumentation for underground construction and tunnelling in soft ground.	12L
Module 3: Instrumentation for dams and embankments.	10L
Module 4: Case histories: Failure investigations in Geotechnical Engineering.	10L

Text / Reference Books:

Geotechnical Instrumentation and Applications – 2023 by Myint Win Bo (Author), Jeffrey Barrett

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	1	3	2	2
CO2	3	3	2	3	3	2
CO3	3	3	2	3	3	3
CO4	3	3	2	3	3	3

RESEARCH METHODOLOGY AND IPR
(CODE: IPR)
L: 2 T: 0 P: 0
TOTAL CONTACT HOURS: 24
CREDIT:2

Course Outcomes:

Students will be able to:

CO1: Understand the meaning, scope, and objectives of a research problem, including approaches for investigation, data collection, analysis, interpretation, and research ethics.

CO2: Analyze literature and technical information to identify gaps, formulate research objectives, and critically evaluate research findings for preparation of research proposals.

CO3: Understand the nature and framework of Intellectual Property Rights (IPR), including patents, designs, trademarks, copyrights, and international cooperation.

CO4: Able to evaluate patent rights, licensing, technology transfer, and emerging trends in IPR, applying knowledge to real-world case studies such as biological systems, computer software, and traditional knowledge.

Course Contents

Module 1: Meaning of research problem, Sources of research problem, Criteria, Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations Plagiarism, Research ethics	6L
Module 2: Effective literature studies approaches, analysis, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.	4L
Module 3: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, and development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT. Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.	10L
Module 4: New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	4L

Text / Reference Books:

Sl No.	Name	Author
1	Research methodology: an introduction for science & engineering students	Stuart Melville and Wayne Goddard
2	Research Methodology: An Introduction	Wayne Goddard and Stuart Melville
3	Research Methodology: A Step by Step Guide for beginners	Ranjit Kumar, 2nd edition
4	Resisting Intellectual Property	Halbert, Taylor & Francis Ltd ,2007.
5	Intellectual Property in New Technological Age	Robert P. Merges, Peter S. Menell, Mark A. Lemley
6	Intellectual Property Rights Under WTO	T. Ramappa, S Chand

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1
CO2	3	3	2	2	2	1
CO3	3	3	3	3	2	2
CO4	2	2	2	2	2	1

ENGLISH FOR RESEARCH PAPER WRITING
(CODE: AUDIT 2)
L: 1 T: 0 P: 0
TOTAL CONTACT HOURS: 12
CREDIT: 0

Course Outcomes:

Students will be able to:

CO1: Able to adopt the principles of technical writing, including planning, structuring paragraphs, sentence clarity, and avoiding ambiguity, redundancy, and plagiarism.

CO2: Analyze and organize research content effectively across all sections of a paper, including Abstract, Introduction, Literature Review, Methods, Results, Discussion, and Conclusions.

CO3: Develop essential writing skills to craft impactful titles, abstracts, and research sections while maintaining clarity, conciseness, and highlighting key findings to write a complete literature review.

CO4: Able to prepare high-quality research papers suitable for first-time submission by applying proper writing techniques, useful phrases, and critical evaluation strategies.

Course Contents

Module 1: Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness: Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction.	2L
Module 2: Clarifying Who Did What, Highlighting Your Findings, Hedging, and Criticizing.	2L
Module 3: Review of the Literature, Methods, Results, Discussion, Conclusions, and the Final Check.	2L
Module 4: Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, and key skills are needed when writing a Review of the Literature. Skills are needed when writing the Methods, skills are needed when writing the Results, skills are needed when writing the Discussion, and skills are needed when writing the Conclusions. Uuseful phrases, how to ensure paper is as good as it could possibly be, the first-time Submission.	6L

Text / Reference Books:

Sl No.	Name	Author
1	Writing for Science, Yale University Press	Goldbort R (2006)
2	How to Write and Publish a Scientific Paper, Cambridge University Press	Day R (2006)
3	Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book	Highman N (1998),
4	English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011	Adrian Wallwork

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	1	2	1	1
CO2	3	3	2	2	2	1
CO3	3	3	2	3	2	2
CO4	3	3	3	3	2	2

GEOTECHNICAL LAB- I
(CODE: GTE191)
L: 0 T: 0 P: 3
TOTAL CONTACT HOURS: 36
CREDIT:2

Course Outcomes:

Students will be able to:

CO1: Apply the principles and procedures of in-situ density measurement using core cutter and sand replacement methods.

CO2: Apply procedure to determine the shear strength characteristics of soil through vane shear and triaxial tests to evaluate soil behavior under different stress conditions.

CO3: Able to develop skills to determine soil compressibility using oedometer.

CO4: Able to develop skills to determine CBR values at OMC.

Course Contents

Module 1: Determination of In-situ density by the core cutter method and sand replacement method	12P
Module 2: Determination of undrained shear strength of soil by vane shear test and shear parameter of soil by Triaxial test	12P
Module 3: Determination of compressibility characteristics of soil by Oedometer test.	6P
Module 4: Determination of CBR of a soil specimen at OMC as per IS code recommendation	6P

BOOKS:

Author(s)	Book Title	Publisher
B.M. Das	*Soil Mechanics Laboratory Manual*	Cengage Learning
V.N.S. Murthy	*Soil Mechanics and Foundation Engineering*	CRC Press

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	1	2	1	1
CO2	3	3	2	3	2	1
CO3	3	3	2	3	2	2
CO4	3	3	3	3	3	2

COMPUTER APPLICATIONS IN GEOTECHNICAL ENGINEERING LAB
(CODE: GTE192)
L: 0 T: 0 P: 3
TOTAL CONTACT HOURS: 36
CREDIT:2

Course Outcomes:

Students will be able to:

CO1: Understand the role of computational tools and programming in geotechnical engineering for data handling, input preparation, and output interpretation.

CO2: Develop shear strength parameters from laboratory and field data, and apply computational techniques to interpret triaxial and direct shear test results.

CO3: Solve problems related to consolidation, and settlement, including calculation of permeability, consolidation parameters, and bearing capacity using computational models.

CO4: Able to apply computational models and FEM-based approaches for the analysis and design of foundations, earth retaining structures, embankments.

Course Contents

Module 1: Introduction to Computational Tools in Geotechnical Engineering: Overview of computer applications in geotechnical analysis and design: Basics of data handling, input preparation, and output interpretation; Role of programming and numerical methods in soil parameter estimation.	8P
Module 3: Determination of Shear Strength Parameters: Computation of shear strength parameters (c and φ) from laboratory/field data; Analysis of triaxial and direct shear test results using software tools; Development of simple scripts for parameter estimation.	8P
Module 4: Consolidation and Settlement Analysis: Computation of consolidation parameters (Cc, Cv, mv); Prediction of primary and secondary settlement; Calculation of safe and allowable bearing capacity using computational techniques.	10P
Module 6: Application of Computational Models in Geotechnical Design: Analysis of Foundations; Earth retaining structures; Embankments and slopes; Introduction to FEM-based approaches for geotechnical problems.	10P

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	1
CO2	3	3	2	3	2	1
CO3	3	3	2	3	3	2
CO4	3	3	3	3	3	2
CO5	3	3	3	3	3	3

2nd Semester							
Course Code	Subject Code	Subject Name	Contact Hours / Week				Credit Points
			L	T	P	Total	
A: THEORY:							
PC	GTE201	Advanced Foundation Engineering- II	3	1	0	4	4
PC	GTE202	Subsoil Investigation	3	1	0	4	4
PE-3	GTE203	A- Advanced Ground Improvement Techniques B- Retaining Structures and Coffer Dam C- Offshore Structures	3	1	0	4	4
PE-4	GTE204	A- Soil Dynamics and Machine Foundation. B- Advanced Ground Water Hydrology. C- Geosynthetics Engineering	3	1	0	4	4
AUDIT2		Disaster Management	1	0	0	1	0
B: LABORATORY:							
Core Lab-III	GTE291	Geotechnical Lab- II	0	0	2	2	2
Core Lab-IV	GTE292	Preparation of geotechnical report	0	0	2	2	2
C: SESSIONAL							
PROJECT & SEMINAR	GTE281	Mini Project with Seminar	0	0	0	2	2
Total of Theory, Practical & Sessional							22

Syllabus-2nd Semester

ADVANCED FOUNDATION ENGINEERING- II
(CODE: GTE 201)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT: 4

Course Outcomes:

Students will be able to:

CO1: Apply the principles of deep foundations, including modes of failure, types of piles, allowable loads, and pile load testing.

CO2: Analyze pile group behavior, pile interference, and response under lateral loads using methods such as Winkler's assumption, elastic analysis, and Brom's method.

CO3: Develop design skills for well foundations, including bearing capacity, settlement, lateral resistance, and mitigation of tilts and shifts.

CO4: Able to design and evaluate capacity of drilled shafts and settlement analysis for practical foundation applications apply construction procedures, load-carrying capacity.

Course Contents

Module 1: Deep Foundation: Modes of failure. Load bearing capacity and settlement of pile foundation. Types of piles. Allowable load, Pile Load test. Dynamic and static formulae.	8L
Module 2: Pile group bearing capacity and settlement. Interference, Behaviour of piles under lateral loading. Winkler's assumption. Pile resistance and deflection under lateral loads, elastic method, Broms method.	16L
Module 3: Well Foundation: Design and Construction. Bearing capacity, settlement and lateral resistance. Tilts and shifts.	12L
Module 4: Drilled Shaft: Construction procedures, Design Considerations, Load Carrying Capacity and settlement analysis.	12L

Text / Reference Books:

1. B. M Das, *Principles of Foundation Engineering*, Thomson Brooks/Cole
2. J. E. Bowles, *Foundation Analysis and Design*, McGraw-Hill Book Company
3. H.G. Poulos, and E.H.Davis, Pile Foundation Analysis and Design, John Wiley and Sons, New York.
4. N.P. Kurien, *Design of Foundation Systems : Principles & Practices*, Narosa, New Delhi 1992
5. H. F. Winterkorn and H Y Fang, *Foundation Engineering Hand Book*, Galgotia Booksource

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	1
CO2	3	2	3	3	3	1
CO3	3	2	3	3	3	2
CO4	3	2	3	3	3	2

SUBSOIL INVESTIGATION
(CODE: GTE 202)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT: 4

Course Outcomes:
Students will be able to:
CO1: Apply principle of carrying out subsurface investigation in the field with determination of ground water table after planning.
CO2: Able to apply different methods of geophysical investigation in the field.
CO3: Able to identify different types of samples and carrying out sampling in the field.
CO4: Able to carry out different in -situ field tests.

Course Contents

Module 1: Introduction and Site Investigation: Introduction to situations where ground improvement becomes necessary; planning of site exploration for preliminary and detailed design groundwater investigation, rock boring, and miscellaneous exploratory techniques.	12L
Module 2: Geophysical explorations such as sounding, probing, and boring methods; excavation methods for exploration,	12L
Module 3: Sampling, types of soil and rock samples, samplers, preservation, shipment, and storage; bore log preparation; pore pressure measurements, core recovery, rock strength, rock quality designation	12L
Module 4: In-situ field testing including SPT, SCPT, DCPT, pressure meter, dilatometer, plate load test.	12L

Text / Reference Books:

1. J. E. Bowles, *Foundation Analysis and Design*, McGraw-Hill Book Company
2. Braja M. Das – *Principles of Geotechnical Engineering*

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	1
CO2	3	2	3	3	3	1
CO3	3	2	3	3	3	2
CO4	3	2	3	3	3	2

ADVANCED GROUND IMPROVEMENT TECHNIQUES
(CODE: GTE 203A)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT: 4

Course Outcomes:

Students will be able to:

CO1: Able to apply the principles, need, and methods of ground improvement, including methods of ground improvement in granular soil, including vibro- floatation and compaction pile etc.

CO2: Able to apply the principles of ground improvement in cohesive soil. vertical drains, and stone columns, including their load-carrying capacity and settlement behavior.

CO3: Develop ground improvement solutions using grouting and soil reinforcement.

CO4: Able to apply soil stabilization techniques with lime, cement, fly-ash-lime, and bitumen stabilization for improving soil properties and foundation performance.

Course Contents

Module 1: Introduction: Need for Ground Improvement: Different methods of Ground improvement, General Principles of Compaction: Mechanics, field procedure, quality control in the field. Ground Improvement in Granular Soil: In-place densification by (i) Vibro-floatation, (ii) Compaction pile, (iii) Vibro-Compaction Piles, (iv) Dynamic Compaction, (v)	16L
Module 2: Types of Drains, Design of vertical Drains, Blasting Ground Improvement in Cohesive Soil: Compressibility, vertical and radial consolidation, preloading methods. Stone Column: Function Design principles, load carrying capacity, construction techniques, and settlement of stone column foundation.	10L
Module 3: Ground Improvement by Grouting and Soil Reinforcement: Grouting in soil, types of grout, desirable characteristics, grouting pressure, grouting methods. Soil Reinforcement: Mechanism, Types of reinforcing elements, reinforcement-soil interaction, Reinforcement of soil beneath the roads, and foundation. Geosynthetics and their application.	12L
Module 4: Soil Stabilization: Lime stabilization-Base exchange mechanism, Pozzolanic reaction, lime soil interaction, lime columns, Design of Foundation on lime columns. Cement stabilization: Mechanism, amount, age and curing. Fly-ash - Lime Stabilization, Soil Bitumen Stabilization.	10L

Text / Reference Books:

1_Hausmann, M.R., Engineering Principles of Ground Modification, McGraw-Hill International Editions, 1990.

2- Yonekura, R., Terashi, M. and Shibazaki, M. (Eds.), Grouting and Deep Mixing, A.A. Balkema, 1966.

3- Ground Improvement Techniques-Bikash chandra chattopadhyay & Joyanta Maity Publisher: PHI Learning.

4- Ground Improvement Techniques By Dr. P. Purushothama Raj, Laxmi Publications

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	1
CO2	3	2	3	3	3	1
CO3	3	2	3	3	3	2
CO4	3	2	3	3	3	2

RETAINING STRUCTURES AND COFFER DAM
(CODE: GTE 203B)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT: 4

Course Outcomes:

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

CO1: Apply the principles of different earth pressure theories, design of retaining walls with provision of drainage.

CO2: Apply the design principles of cantilever sheet pile walls and anchored bulkheads,

CO3: Develop design solutions for cellular coffer dams and braced excavation and cellular cofferdams.

CO4: Able to design tunnels, and shafts, considering pressure distribution, tunnel lining and ground loss.

Course Contents

Module 1: Earth pressure theories, conditions of applicability, arching effect; Retaining walls, different types and their stability, design considerations, drainage provisions.	10L
Module 2: Cantilever sheet pile wall; Anchored bulkhead, Free and fixed earth support methods, types of sheet piles and construction aspects.	12L
Module 3: Braced excavation, types, earth pressure, effect of wall rigidity and sequence of construction, cellular coffer dams, design procedures, interlock.	14L
Module 4: Design of tunnels and shafts, pressure distribution, design of tunnel lining, methods of tunnelling, ground loss.	12L

Text / Reference Books:

1. Basic & Applied soil mechanics – Gopal Ranjan & ASR Rao, New Age International Publishers, 2011.
2. Foundation design by W. C. Teng, Prentice Hall,1962
3. Analysis and design of foundations by Bowles. J. W McGraw Hill, 4th edition, 1955.
4. Soil mechanics in engineering and practice by Karl Terzaghi, Ralph B. Peck, Gholamreza Mesri, 3rd Edition. Wiley India Pvt Ltd, 2010.
5. B. M Das, Principles of Foundation Engineering, Thomson Brooks/Cole
6. Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering- V. N. S. Murthy

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	1
CO2	3	2	3	3	3	1
CO3	3	2	3	3	3	2
CO4	3	2	3	3	3	2

OFFSHORE STRUCTURES
(CODE: GTE 203C)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT: 4

Course Outcomes:

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

CO1: Explain the types, concepts, and construction methods of offshore structures, and interpret international design codes (API, DNV, Lloyd's, etc.) for structural design compliance.

CO2: Analyze environmental and operational loads acting on offshore platforms using analytical models and approximate methods, and evaluate the structural response under static and dynamic conditions.

CO3: Assess the behaviour, failure modes, and fatigue performance of tubular joints in offshore structures, applying API code provisions for safe design.

CO4: Evaluate corrosion mechanisms in offshore environments and propose appropriate prevention and protection systems, including cathodic protection and corrosion monitoring methods.

Course Contents

Module 1: Types of offshore structures and conceptual development - Analytical models for jacket structures - Materials and their behaviour under static and dynamic loads – Statutory regulations - Allowable stresses - Various design methods and Code Provisions – Design specification of API, DNV, Lloyd's and other classification societies - Construction of jacket and gravity platforms	10L
Module 2: Operational loads - Environmental loads due to wind, wave, current and buoyancy - Morison's Equation - Maximum wave force on offshore structure - Concept of Return waves - Principles of Static and dynamic analyses of fixed platforms - Use of approximate methods - Design of structural elements.	10L
Module 3: Introduction to tubular joints - Possible modes of failure - Eccentric connections and offset connections - Cylindrical and rectangular structural members – In plane and multi-plane connections - Parameters of in-plane tubular joints - Kuang's formulae – Elastic stress distribution - Punching shear Stress - Overlapping braces - Stress concentration - Chord collapse and ring stiffener spacing - Stiffened tubes - External hydrostatic pressure - Fatigue of tubular joints - Fatigue behaviour - S-N curves - Palmgren-Miner cumulative damage rule - Design of tubular joints as per API Code	16L
Module 4: Corrosion - Corrosion mechanism - Types of corrosion - Offshore structure corrosion zones – Biological corrosion - Preventive measures of Corrosion - Principles of cathode protection systems - Sacrificial anode method and impressed current method – Online corrosion monitoring - Corrosion fatigue	12L

Text / Reference Books:

1- Dawson, T. H., Offshore Structural Engineering, Prentice Hall, 1983.
2- API RP 2A., Planning, Designing and Constructing Fixed Offshore Platforms, API.
3- McClelland, B & Reifel, M. D., Planning & Design of fixed Offshore Platforms, Van Nostrand, 1986.
4- Graff, W. J., Introduction to Offshore Structures, Gulf Publ. Co.1981.
5- Reddy, D. V & Arockiasamy, M., Offshore Structures Vol.1 & 2, Kreiger Publ. Co.1991.

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	1
CO2	3	2	3	3	3	1
CO3	3	2	3	3	3	2
CO4	3	2	3	3	3	2

SOIL DYNAMICS AND MACHINE FOUNDATION
(CODE: GTE 204A)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT: 4

Course Outcomes:

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

CO1: Understand the strength and deformation characteristics of soil under dynamic loads, including determination of dynamic coefficients, shear modulus, and elastic constants.

CO2: Analyze transient and shock loading on cohesionless soils, damping mechanisms, and elastic wave propagation in soil.

CO3: Develop designs for machine foundations, including foundations for reciprocating, rotary, and impact-type machines, with vibration isolation considerations.

CO4: Able to perform dynamic analysis of pile foundations and transformer/generator foundations for practical engineering applications.

Course Contents

Module 1: Strength and deformation of soil under dynamic loads; Determination of dynamic coefficients, shear modulus and elastic constants of soil.	8L
Module 2: Transient/shock loading on cohesionless soil; Damping in soil – geometrical and internal damping; Elastic wave propagation theory.	12L
Module 3: Vibration theory related to machine foundations; design of foundation for reciprocating and rotary machines, foundation for impact-type loading; vibration isolation technique.	16L
Module 4: Dynamic analysis of Pile Foundation. Dynamic Analysis of T.G. Foundation.	12L

Text / Reference Books:

Sl. No	Name	Author	Publishers
1	Foundation Analysis & Design	J.E. Bowels	McGraw Hill
2	Principles of Foundation Engineering	B.M. Das	Thomson Book
3	Foundation Design Manual	N.V. Nayak	Dhanpat Rai Publication Pvt. Ltd
4	Foundations for Machines: Analysis and Design	Shamsher Prakash, Vijay K. Puri	Wiley Series in Geotechnical Engineering
6	Handbook of Machine Foundation	P. Srinivasulu & C.V. Vaidyanathan	Tata McGraw Hill
7	Soil Dynamics and Machine Foundations	Swami Saran	Galgotia Publications
8	Principles of Soil Dynamics	Braja M. Das & G. V. Ramana (Gunturi)	

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	1
CO2	3	2	3	3	3	1
CO3	3	2	3	3	3	2
CO4	3	2	3	3	3	2

ADVANCED GROUND WATER HYDROLOGY
(CODE: GTE 204B)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT: 4

Course Outcomes:

Students will be able to:

CO1: Understand the role of groundwater in the hydrologic cycle, its occurrence, movement, and hydrogeology of aquifers.

CO2: Analyze groundwater flow and well hydraulics using Darcy's law, steady and unsteady radial flows, characteristic well losses, and specific capacity.

CO3: Develop methods for surface and subsurface groundwater investigation, including geologic, geophysical, and remote sensing techniques, as well as well construction, yield tests, and rehabilitation.

CO4: Able to apply groundwater management strategies, including basin management, conjunctive use, artificial recharge, and mitigation of saline water intrusion in aquifers**.**

Course Contents

Module 1: Introduction: Role of groundwater in the hydrologic cycle, problems and perspectives. Occurrence and movement of groundwater, hydrogeology of aquifers.	8L
Module 2: Darcy's law, general flow equations. Groundwater and Well Hydraulics: steady and unsteady radial flows in aquifers, partially penetrating wells, characteristic well losses, specific capacity.	8L
Module 3: Surface and Subsurface investigations of Groundwater: Geologic methods, remote sensing, geophysical exploration, electrical resistivity and seismic refraction, logging techniques. Water wells: methods of construction, yield tests, protection and rehabilitation of wells.	16L
Module 4: Management of Groundwater: concepts of basin management, conjunctive use, mathematical modelling, artificial groundwater recharge: concepts, recharge methods, recharge mounds, induced recharge. Saline water intrusion in aquifers.	16L

Text / Reference Books:

1. Todd D.K., Mays L.W. , Groundwater Hydrology, Wiley, (2004).
2. Raghunath H.M., Ground Water , New Age International Publishers, (2007).
3. Schwarz F., Zhang H., Fundamentals of Ground Water, Wiley, (2002).
4. Fitts C., Groundwater Science, Academic Press, (2012).
5. Bear J., Hydraulics of Groundwater, Dover Publications, (2007).

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	1
CO2	3	2	3	3	3	1
CO3	3	2	3	3	3	2
CO4	3	2	3	3	3	2

GEOSYNTHETICS ENGINEERING
(CODE: GTE 204C)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT: 4

Course Outcomes:

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

CO1: Explain the types, functions, and material behavior of geosynthetics and their roles in geotechnical engineering applications.

CO2: Analyze and design geosynthetic solutions for soil reinforcement, filtration, drainage, and separation using relevant codes and standards.

CO3: Evaluate the performance of geomembranes, geocomposites, and geosynthetic clay liners in environmental and hydraulic engineering applications.

CO4: Apply advanced geosynthetic techniques to real-life case studies, propose sustainable design solutions, and assess long-term performance.

Course Contents

Module 1: Introduction to Geosynthetics Types of geosynthetics: geotextiles, geogrids, geomembranes, geonets, geocomposites, geocells Manufacturing methods and material properties. Functions of geosynthetics: separation, filtration, drainage, reinforcement, barrier, and protection, Test methods and standards (ASTM, IS codes, ISO)	12L
Module 2: Geotextiles and Geogrids in Soil Systems Applications of geotextiles in pavements, railways, embankments, and drainage systems Filtration and drainage design principles, Geogrid reinforcement of slopes, retaining walls, and foundations, Analytical models for soil–geosynthetic interaction, Design guidelines as per FHWA, IRC, IS codes	12L
Module 3: Geomembranes, Geocomposites, and Environmental Applications Geomembranes as barriers: properties, durability, and chemical resistance, Geosynthetic clay liners (GCLs) and geocomposites, Applications in landfills, canals, reservoirs, and waste containment systems, Leakage detection, service life assessment, and performance monitoring Case studies in environmental geotechnics	12L
Module 4: Advanced Applications and Case Studies Geosynthetics in ground improvement: geocells, basal reinforcement, embankment over soft soils. Coastal and hydraulic applications: erosion control mats, geotextile tubes, and coastal protection works. Seismic applications of geosynthetics. Recent developments and sustainability aspects in geosynthetic engineering. Case studies of national and international projects	12L

Text / Reference Books:

Sl. No	Name of Book / Reference	Author(s)	Publisher / Year
1	Design with Geosynthetics	R.M. Koerner	Prentice Hall, 6th Edition, 2012
2	Geosynthetics and Their Applications	S.K. Shukla (Ed.)	Thomas Telford, 2002
3	Engineering with Geosynthetics	G. Venkatappa Rao & G.V.S. Babu	Tata McGraw-Hill, 2006
4	Geosynthetics in Civil Engineering	R.W. Sarsby (Ed.)	Woodhead Publishing, 2007
5	Handbook of Geosynthetic Engineering	S.K. Shukla	ICE Publishing, 2007
6	Geosynthetics in Geotechnical and Geoenvironmental Engineering	G.V.S. Babu	Universities Press, 2013

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	1
CO2	3	2	3	3	3	1
CO3	3	2	3	3	3	2
CO4	3	2	3	3	3	2

DISASTER MANAGEMENT
(CODE: AUDIT 1)
L: 1 T: 0 P: 0
TOTAL CONTACT HOURS: 24
CREDIT: 0

Course Outcomes:

Students will be able to:

CO1: Understand the fundamental concepts of disasters, differentiate between hazards and disasters, and recognize their impact on human life, economy, and the environment.

CO2: Identify and classify various natural and man-made disasters, and understand their immediate and long-term effects on populations and ecosystems.

CO3: Analyze disaster-prone areas, assess risks using scientific and community-based methods, and understand national and global strategies for disaster preparedness.

CO4: Develop strategies for disaster preparedness and mitigation, applying both structural and non-structural measures, and understand India's national programs and global best practices.

Course Contents

Module 1: Introduction to Disasters Definition and concept of disaster; factors and significance, Difference between hazard and disaster, Natural vs. man-made disasters: differences, nature, types, and magnitude, Repercussions of disasters and hazards: economic damage, loss of human and animal life, ecosystem destruction	6L
Module 2: Types of Disasters **Natural Disasters:** Earthquakes, volcanic eruptions, cyclones, tsunamis, floods, droughts, famines, landslides, avalanches, **Man-Made Disasters:** Nuclear reactor meltdown, industrial accidents, oil spills, disease outbreaks and epidemics, war and conflicts, Post-disaster diseases and epidemics	6L
Module 3: Disaster-Prone Areas and Risk Assessment Disaster-prone areas in India: seismic zones, flood and drought-prone regions, landslide and avalanche-prone areas, cyclonic and coastal hazards including tsunamis, Monitoring and evaluation of disaster risk: use of remote sensing, meteorological data, media reports, Disaster risk concept, elements, and reduction strategies, Techniques of risk assessment, global cooperation, and people's participation	6L
Module 4: Disaster Preparedness and Mitigation Preparedness: government and community initiatives, Strategies for survival during disasters, Disaster mitigation: meaning, concepts, strategies, emerging trends, Structural vs. non-structural mitigation, Programs of disaster mitigation in India	6L

Text / Reference Books:

Sl No.	Name	Author
1	Disaster Management in India: Perspectives, issues and strategies	R. Nishith, Singh AK, New Royal book Company
2	Disaster Mitigation Experiences And Reflections	Sahni, Pardeep Et.Al. (Eds.), Prentice Hall Of India, New Delhi.
3	Goel S. L. , Disaster Administration And Management Text And Case Studies	Deep &Deep Publication Pvt. Ltd., New Delhi.

CO – PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	1	2	3
CO2	3	2	3	1	3	3
CO3	3	2	3	2	3	3
CO4	3	2	3	2	3	3

GEOTECHNICAL LAB- II
(CODE: GTE291)
L: 0 T: 0 P: 3
TOTAL CONTACT HOURS: 36
CREDIT:2

Course Outcomes:

Students will be able to:

CO1: Understand the concept of relative density, its significance in soil behavior, and perform standard tests for its determination, including calculations and interpretation of results.

CO2: Gain foundational knowledge of geotextile materials, their applications, and the relevant testing standards, specifications, and sampling methods for quality assessment.

CO3: Develop practical skills in conducting thickness and apparent opening size tests on geotextiles, and analyze the results to evaluate filtration and structural performance.

CO4: Acquire competency in advanced mechanical testing of geotextiles, including tensile strength, tear and puncture resistance, and cone drop tests, with the ability to interpret results for engineering applications.

Course Contents

Module 1: Determination of Relative Density: Overview of relative density and its significance; apparatus, IS code procedures; calculation and interpretation of results.	6P
Module 2: Introduction to Geotextiles and Testing Standards: Overview of geotextile materials; importance of geotextile testing; relevant standards and specifications; sampling methods.	6P
Module 3: Thickness and Apparent Opening Size Tests (a) Thickness test – principles and procedure; factors affecting thickness measurement. (b) Sieve test – determination of apparent opening size and filtration properties.	6P
Module 4: **a)** Tensile Strength Test on Geotextiles: Methods of tensile strength testing; equipment setup and precautions; interpretation of tensile strength and elongation characteristics. **b)** Tear Resistance and Puncture Resistance Tests: Tear resistance test – procedure, significance, and applications; puncture resistance test – static and dynamic puncture evaluation; failure analysis. **c)** Cone Drop Test and Advanced Testing Practices: Principle and procedure of cone drop test for geotextiles; limitations and interpretations; brief on durability and environmental resistance testing; data reporting.	18P

Text / Reference Books:

Author(s)	Book Title	Publisher
B.M. Das	*Soil Mechanics Laboratory Manual*	Cengage Learning
V.N.S. Murthy	*Soil Mechanics and Foundation Engineering*	CRC Press

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	1
CO2	3	2	3	3	3	1
CO3	3	2	3	3	3	2
CO4	3	2	3	3	3	2

PREPARATION OF GEOTECHNICAL REPORT
(CODE: GTE292)
L: 0 T: 0 P: 3
TOTAL CONTACT HOURS: 36
CREDIT:2

Course Outcomes:
Students will be able to:
CO1: Understand the purpose, scope, and planning of sub-soil investigations and prepare soil investigation reports following IS codes.
CO2: Demonstrate knowledge of field investigation techniques, including auger boring and bored pile installation, with proper sampling, quality control, and borehole log interpretation.
CO3: Apply plate load test procedures to evaluate bearing capacity and interpret load-settlement behavior for foundation design.
CO4: Conduct and interpret penetration tests (SPT, dynamic and static cone), and prepare comprehensive soil investigation reports for foundation design recommendations.

Course Contents

Module 1: Introduction and Planning of Sub-Soil Investigation Purpose and scope of sub-soil investigation; planning and sequencing of field and laboratory tests; IS codes and reporting guidelines; preparation of soil investigation reports.	9L
Module 2: Field Investigation Techniques (a) Auger boring – principle, equipment, procedure, sampling techniques, precautions, and interpretation of borehole logs. (b) Installation of bored piles – methods, quality control, load transfer mechanisms, and field implementation considerations.	9L
Module 3: Bearing Capacity Evaluation Plate load test – objective, test setup as per IS:1888, execution, interpretation of load-settlement curves, and correlation with allowable bearing capacity.	9L
Module 4: Penetration Testing and Soil Reporting (a) Standard Penetration Test (SPT) – procedure, N-value corrections, limitations. (b) Dynamic and Static Cone Penetration Tests – principles, advantages, interpretation, and field correlations. Preparation of comprehensive soil investigation reports including field and laboratory results, and design recommendations for foundations.	9L

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	1
CO2	3	2	3	3	3	1
CO3	3	2	3	3	3	2
CO4	3	2	3	3	3	2

MINI PROJECT WITH SEMINAR
(CODE: GTE281)
L: 0 T: 0 P: 2
TOTAL CONTACT HOURS: 24
CREDIT: 2

Course Outcomes:

At the end of the course:

CO1: Identify and define geotechnical engineering problems by analyzing site conditions and engineering requirements.

CO2: Develop feasible engineering solutions using appropriate design methodologies and problem-solving approaches.

CO3: Verify and analyze experimental data, conduct laboratory or field experiments, and draw meaningful conclusions to support engineering decisions.

CO4: Characterize engineering materials, evaluate their properties, and apply relevant software tools for modeling and solving engineering problems.

Course Contents

Module 1: Problem identification in geotechnical engineering.	4P
Module 2: Solution development for identified engineering problems.	4P
Module 3: Verification and analysis of available experimental data. Conducting experiments in various engineering subjects.	8P
Module 4: Material characterization and property evaluation. Application of software tools for engineering problem solving.	8P

CO – PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	3	2	2
CO2	3	2	3	3	3	2
CO3	3	3	3	2	2	2
CO4	3	3	3	2	3	2

3rd Semester							
Course Code	Subject Code	Subject Name	Contact Hours / Week				Credit Points
			L	T	P	Total	
A: THEORY:							
PE	GTE301	A. Geotechnical Earthquake Engineering B. Remote Sensing and its application in Geo Technical Engineering C. Reinforced Earth	3	1	0	4	4
OE	GTE302	A. Industrial Safety B. Operations Research C. Cost Management of Engineering Projects D. Waste to Energy	3	1	0	4	4
C: SESSIONAL							
Thesis/ Dissertation	GTE381	Dissertation- Stage I	0	0	24	24	12
Total of Theory, Practical & Sessional							20

Syllabus-3rd Semester

GEOTECHNICAL EARTHQUAKE ENGINEERING
(CODE: GTE 301A)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT: 4

Course Outcomes:

Students will be able to:

CO1: Understand fundamental concepts of seismology, earthquake mechanics, and tectonic processes influencing seismic activity.
CO2: Analyze strong ground motion and perform deterministic and probabilistic seismic hazard assessments.
CO3: Evaluate wave propagation, ground response, and liquefaction hazards for different soil conditions.
CO4: Apply seismic design principles for slopes and retaining structures, and implement soil improvement techniques to mitigate seismic risks.

Course Contents

Module 1: Fundamentals of Seismology and Earthquakes Introduction to seismology; earthquakes; continental drift and plate tectonics; elastic rebound theory; earthquake location and magnitude.	12L
Module 2: Strong Ground Motion and Seismic Hazard Analysis Measurement of strong ground motion; estimation of ground motion parameters; deterministic and probabilistic seismic hazard analysis.	12L
Module 3: Wave Propagation and Ground Response Wave propagation in semi-infinite and layered media; attenuation of stress waves; one-, two-, and three-dimensional ground response analysis; liquefaction phenomena, susceptibility, evaluation, and effects.	12L
Module 4: Seismic Design and Remediation Measures Seismic slope stability; seismic design of retaining walls; soil improvement techniques for mitigation of seismic hazards.	12L

Text / Reference Books:

1. S.L. Kramer, *Geotechnical Earthquake Engineering*, Pentice Hall, international series, Pearson Education (Singapore) Pvt. Ltd., 2004.
2. S.Saran, *Soil Dynamics and Machine Foundation*, Galgotia publications Pvt. Ltd., New Delhi 1999.
3. Ansal, *Recent Advances in Earthquake Geotechnical Engineering and Microzonation*, Springer, 2006.
4. Towhata, *Geotechnical Earthquake Engineering*, Springer , 2008.

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	1
CO2	3	2	3	3	3	1
CO3	3	2	3	3	3	2
CO4	3	2	3	3	3	2

REMOTE SENSING AND ITS APPLICATION IN GEO TECHNICAL ENGINEERING
(CODE: GTE 301B)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT: 4

Course Outcomes:

Students will be able to:

CO1: Understand the principles, components, and types of remote sensing systems and their relevance to satellite data acquisition.

CO2: Apply image interpretation and digital classification techniques to extract thematic information from remotely sensed data.

CO3: Utilize GPS and GIS tools for accurate data acquisition, storage, and spatial analysis of engineering and geotechnical information.

CO4: Implement remote sensing and GIS for terrain investigation, resource mapping, geotechnical analysis, and monitoring of seismic and landslide hazards.

Course Contents

Module 1: Fundamentals of Remote Sensing Introduction to remote sensing; definitions and components of a remote sensing system; spectral windows and signatures; radiometric quantities; satellite orbits, image acquisition, swath coverage, and repeativity; passive and active sensors (Radar, Lidar, SAR); spectral and spatial resolution with relevance to Indian satellites; types of remotely sensed data products	12L
Module 2: Image Interpretation and Digital Classification Photographic image characteristics (colour, tone, texture); photo-interpretation keys and techniques; digital image classification and thematic information extraction.	12L
Module 3: GPS and GIS Fundamentals Global Positioning System (GPS) – components, space/control/user segments, observation methods, and advantages; Geographic Information System (GIS) – definitions, components, data acquisition, raster/vector formats, scanners and digitisers; integration of GPS and GIS for storage and analysis of thematic data from remotely sensed images.	12L
Module 4: Applications in Engineering and Geotechnical Investigations Remote sensing and GIS for terrain investigation and resource mapping; extraction of topographic information and digital terrain model generation; seismic slope stability, retaining wall design, soil improvement, and geological mapping for geotechnical investigations; monitoring landslide-prone areas; application of visible, infrared, and microwave remote sensing for soil characterization (type, grain size, moisture).	12L

Text / Reference Books:

1. Lillesand T.M. and Kiefer R. W., *Remote Sensing and image interpretation,* John Wiley and Sons. New York.
2. J. B. Campbell, *Introduction to remote sensing* , Taylor & Francis, London.
3. J. R.Jensen, *Introductory Digital Image Processing*, Prentice Hall International Ltd., London.
4. Kennie, T. J. M. and Matthews M. C., *Remote Sensing in Civil Engineering*, Surrey University Press, Glasgow.

CO – PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	3	2	1
CO2	3	2	3	3	3	1
CO3	3	2	3	3	3	2
CO4	3	2	3	3	3	2

REINFORCED EARTH
(CODE: GTE 301C)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT: 4

Course Outcomes:

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

CO1: Understand the fundamentals of reinforced earth, including soil-reinforcement interaction, cohesion theories, reinforced soil models, and stress distribution in reinforced soil structures.

CO2: Analyze enhanced confining pressure concepts, findings from experimental studies, and comparative evaluation of models for stability and design of reinforced earth systems.

CO3: Develop knowledge of randomly reinforced soils, evaluate laboratory study limitations, and apply reinforced soil concepts in practical geotechnical engineering projects.

CO4: Able to design and evaluate reinforced earth structures, including selection and placement of reinforcement, construction considerations, soil-reinforcement interaction, and performance assessment.

Course Contents

Module 1: Introduction to reinforced earth; basic mechanism of soil reinforcement; concept of improved soil behaviour through reinforcement; Andsobropis cohesion concept; LCPC cohesion theory; NSW cohesion theory; sigma model and its application in soil-reinforcement interaction; introduction to stress distribution models in reinforced earth structures.	10L
Module 2: Detailed discussion on the reinforced soil model and its relevance in reinforced soil; enhanced confining pressure concept and its role in stability; comparative evaluation of different models and their applicability to the design of reinforced earth structures.	16L
Module 3: Concept of randomly reinforced soil; mechanism of strength improvement; advantages and limitations of laboratory studies on reinforced soils; practical applications in geotechnical engineering projects.	12L
Module 4: Design principles for reinforced earth structures; selection and placement of reinforcement; considerations in construction methods; soil–soil-reinforcement bond and interaction behaviour; failure modes and performance evaluation.	10L

Text / Reference Books:

1. Geo-textiles and Geo-membranes in Civil Engg. Gerard P.T.M. Van Santvrot A. A. Balkema, Oxford and IBH publishing company, New Delhi.
2. Reinforced Soil and Geo-textiles- J. N. Mandal, proceedings FIGC- 1988, Oxford and IBH publishing company private Ltd., New Delhi.
3. Geosynthetics: Applications, Design and construction- R. J. Tarmat, proceedings First Europian Geosynthetics Conference, Netherland A. A. Balkema, publisher-Brookfield, U.S.A.
4. Geosynthetics World. – J. N. mandal, Willey Eastern Limited, New Delhi.
5. Geotextiles. N.W.M. John, Blackie, Glasgow and London.
6. R. M. Korner, *Design with Geosynthetics*, Prentice Hall, New Jersy, 3rd Edn. 2002

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	1
CO2	3	2	3	3	3	1
CO3	3	2	3	3	3	2
CO4	3	2	3	3	3	2

INDUSTRIAL SAFETY
(CODE: GTE 302A)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT: 4

Course Outcomes:

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

CO1: Understand industrial safety principles, recognize mechanical and electrical hazards, and apply preventive measures in compliance with relevant safety regulations.

CO2: Comprehend maintenance engineering concepts, types of maintenance, and the role of maintenance in optimizing equipment life and cost.

CO3: Analyze wear and corrosion mechanisms, apply lubrication methods, and utilize fault tracing techniques for troubleshooting various engineering systems.

CO4: Plan and implement periodic and preventive maintenance programs for mechanical and electrical equipment to enhance reliability and operational efficiency.

Course Contents

Module 1: Industrial Safety and Health Accidents – causes, types, results, and control; mechanical and electrical hazards and preventive measures; salient points of the Factories Act 1948 related to health, safety, and welfare (washrooms, drinking water, lighting, cleanliness, fire, guarding, pressure vessels); safety colour codes; fire prevention and firefighting equipment and methods.	10L
Module 2: Maintenance Engineering Fundamentals Definition, aims, and functions of maintenance engineering; responsibilities of the maintenance department; types of maintenance; maintenance tools and their applications; maintenance cost, replacement economy, and equipment service life.	10L
Module 3: Wear, Corrosion, and Fault Tracing Wear – types, causes, effects, and reduction methods; lubricants and lubrication techniques (screw down grease cup, pressure grease gun, splash, gravity, wick feed, side feed, ring); corrosion – types, causes, factors, and prevention; fault tracing – concepts, decision tree method, sequence of fault finding, common faults in machine tools, hydraulic, pneumatic, automotive, thermal, and electrical equipment.	14L
Module 4: Periodic and Preventive Maintenance Concept, need, and procedures for periodic inspection, degreasing, cleaning, repairing, and overhauling of mechanical and electrical components; preventive maintenance – definition, need, steps, advantages, and program scheduling; repair cycle concept and importance; procedures for maintenance of machine tools, pumps, air compressors, DG sets, and electric motors.	14L

Text / Reference Books:

Sl No.	Name	Author
1	Maintenance Engineering Handbook,	Higgins & Morrow, Da Information Services
2	Maintenance Engineering,	H. P. Garg, S. Chand and Company.
3	Pump-hydraulic Compressors	Audels, Mcgrew Hill Publication
4	Foundation Engineering Handbook	Winterkorn, Hans, Chapman & Hall London.

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	3	1	2	3
CO2	3	2	3	1	3	3
CO3	3	2	3	1	3	2
CO4	3	2	3	2	3	2

OPERATIONS RESEARCH
(CODE: GTE 302B)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT: 4

Course Outcomes:

At the end of the course, the student should be able to:

CO1: Formulate and solve linear programming and inventory control problems using simplex and related optimization techniques.

CO2: Apply duality, revised simplex, and parametric programming methods to advanced linear programming problems and perform sensitivity analysis.

CO3: Analyze and solve nonlinear programming and network flow problems, including CPM and PERT for project scheduling.

CO4: Develop solutions for complex operations research problems including scheduling, sequencing, dynamic programming, game theory, and simulation models.

Course Contents

Module 1: Linear Programming and Optimization Techniques Introduction to optimization techniques; model formulation; general linear programming (L.P.) formulation; simplex techniques; sensitivity analysis; inventory control models.	12L
Module 2: Advanced Linear Programming and Duality Formulation of L.P. problems; graphical solution; revised simplex method; duality theory; dual simplex method; sensitivity analysis; parametric programming.	12L
Module 3: Nonlinear Programming and Network Analysis Nonlinear programming problems; Kuhn-Tucker conditions; minimum cost flow and maximum flow problems; critical path method (CPM) and program evaluation review technique (PERT).	12L
Module 4: Advanced Operations Research Techniques Scheduling and sequencing problems (single and multiple server models); deterministic and probabilistic inventory models; geometric programming; competitive models; multi-channel problems; dynamic programming; flow in networks; elementary graph theory; game theory; simulation techniques.	12L

Text / Reference Books:

Sl No.	Name	Author
1	Operations Research, An Introduction,	H.A Taha, PHI, 2008
2	Principles of Operations Research,	H.M. Wangner, PHI, Delhi 1982
3	Introduction to Optimisation: Operations Research,	J.C. Pant, Jain Brothers, Delhi, 2008
4	Operations Research	Hitler Libermann, McGraw Hill Pub. 2009

CO – PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	1	2	2
CO2	3	2	3	1	3	2
CO3	3	2	3	2	3	2
CO4	3	2	3	2	3	2

COST MANAGEMENT OF ENGINEERING PROJECTS
(CODE: GTE 302B)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT: 4

Course Outcomes:

The objectives of this course are to:

CO1: Understand strategic cost management concepts and apply cost information for effective managerial decision-making.

CO2: Manage project costs efficiently through planning, execution, control, and monitoring using project management tools and techniques.

CO3: Analyze cost behavior, perform profit planning, and apply standard costing and variance analysis for informed decision-making.

CO4: Apply advanced cost management techniques, pricing strategies, and quantitative methods for optimizing costs and improving organizational performance.

Course Contents

Module 1: Strategic Cost Management and Decision-Making Introduction to strategic cost management; relevant, differential, incremental, and opportunity costs; objectives of a costing system; inventory valuation; creation of databases for operational control; data provision for managerial decision-making.	10L
Module 2: Project Cost Management and Execution Project concepts, types, and management; stages of project execution from conception to commissioning; detailed engineering activities; pre-project clearances; project team roles; project site data requirements; project contracts; execution, cost control, bar charts, network diagrams, and commissioning.	10L
Module 3: Cost Behavior, Profit Planning, and Standard Costing Cost behavior analysis; marginal costing and absorption costing; break-even and cost-volume-profit analysis; decision-making problems; standard costing and variance analysis.	12L
Module 4: Advanced Cost Management Techniques and Quantitative Methods Pricing strategies (target costing, life-cycle costing, Pareto analysis); costing in service sectors; JIT, MRP, ERP, TQM, Theory of Constraints; activity-based cost management, benchmarking, balanced scorecard, value-chain analysis; budgetary control (flexible, performance, zero-based budgets); measurement of divisional profitability; transfer pricing; quantitative techniques – linear programming, PERT/CPM, transportation and assignment problems, simulation, and learning curve theory.	16L

Text / Reference Books:

Sl No.	Name	Author
1	Cost Accounting A Managerial Emphasis	Prentice Hall of India, New Delhi
2	Advanced Management Accounting	Charles T. Horngren and George Foster,
3	Management & Cost Accounting	Robert S Kaplan Anthony A. Alkinson,
4	Principles & Practices of Cost Accounting	Ashish K. Bhattacharya, A. H. Wheeler publisher

CO – PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	1	2	2
CO2	3	2	3	1	3	2
CO3	3	2	3	1	3	2
CO4	3	2	3	2	3	2

WASTE TO ENERGY
(CODE: GTE 302D)
L: 3 T: 1 P: 0
TOTAL CONTACT HOURS: 48
CREDIT: 4

Course Outcomes:

After successful completion of this course, students will be able to:

CO1: Understand the classification of waste and the fundamental concepts of energy recovery from different types of biomass and waste materials.

CO2: Analyze and design biomass pyrolysis and gasification systems for thermal and electrical energy production.

CO3: Evaluate and operate various biomass combustion devices and stoves for efficient energy utilization.

CO4: Apply biogas and advanced bioenergy technologies, including biofuel production and urban waste-to-energy systems, for sustainable energy solutions.

Course Contents

Module 1: Introduction to Energy from Waste Classification of waste as fuel (agro-based, forest residue, industrial waste, municipal solid waste); overview of conversion devices including incinerators, gasifiers, and digesters; potential and significance of waste-to-energy systems.	10L
Module 2: Biomass Pyrolysis and Gasification Pyrolysis – types (slow and fast), manufacture of charcoal, pyrolytic oils and gases, yields, and applications; biomass gasification – fixed bed, downdraft, updraft, and fluidized bed gasifiers, design, construction, operation, gasifier burner arrangement for thermal applications, gasifier-engine arrangement for electrical power, and equilibrium and kinetic considerations.	12L
Module 3: Biomass Combustion and Utilization Biomass stoves – improved chullahs and exotic designs; fixed bed, inclined grate, and fluidized bed combustors – design, construction, and operation; practical applications of biomass combustion systems.	12L
Module 4: Biogas and Advanced Bioenergy Systems Biogas properties, plant technology, and design; biomass resources and classification; biomass conversion processes – thermochemical (direct combustion, gasification, pyrolysis, liquefaction) and biochemical (anaerobic digestion); types of biogas plants; alcohol and biodiesel production; urban waste-to-energy conversion; bioenergy programs in India.	14L

Text / Reference Books:

Sl No.	Name	Author
1	Non Conventional Energy	Desai, Ashok V., Wiley Eastern Ltd., 1990.
2	Biogas Technology - A Practical Hand Book	Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3	Biomass Conversion and Technology	C. Y. Were Ko-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

CO – PO Mapping:

COs	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	3	1	2	2
CO2	3	2	3	1	3	2
CO3	3	2	3	2	3	2
CO4	3	2	3	2	3	2

4th Semester							
Course Code	Subject Code	Subject Name	Contact Hours / Week				Credit Points
			L	T	P	Total	
C: SESSIONAL							
Thesis/ Dissertation	GTE481	Dissertation- Stage II - Final (Continued from Semester-3)	0	0	32	32	16
Thesis/ Dissertation	GTE482	Comprehensive Exam (Viva-Voce)	0	0	0	0	6
Total of Theory, Practical & Sessional							22