REVISED SHCEME

For

POST GRADUATE PROGRAMME

MASTER'S TECHNOLOGY (M. TECH)

IN

GEOTECHNICAL ENGINEERING

(BATCH 2025 ONWARDS)

DEPARTMENT OF CIVIL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY

SRINAGAR-190006, J&K, INDIA

ABOUT THE INSTITUTE

National Institute of Technology, Srinagar was established in 1960 as the Regional Engineering College, Srinagar. The Institute acquired the status of NIT in August 2003 and attained full autonomy in its Academics. In 2007, it became an Institute of National Importance. It is one of the 31 NITs and it is directly under the control of the MHRD. The Institute is situated on the banks of the world-famous Dal Lake. Besides running various undergraduate, postgraduate and doctoral programmes, Institute has also established an Innovation Incubation and Entrepreneurship Development (IIED) center.

VISION AND MISSION OF THE INSTITUTE

VISION OF THE INSTITUTE:

To establish a unique identity of a pioneer technical Institute by developing a high quality technical manpower and technological resources that aim at economic and social development of the nation as a whole and the region, in particular, keeping in view the global challenges.

MISSION OF THE INSTITUTE:

M1. To create a strong and transformative technical educational environment in which fresh ideas, moral principles, research and excellence nurture with international standards.

M2. To prepare technically educated and broadly talented engineers, future innovators and entrepreneurs, graduates with understanding of the needs and problems of the industry, the society, the state and the nation.

M3. To inculcate the highest degree of confidence, professionalism, academic excellence and engineering ethics in budding engineers.

PROGRAM OUTCOMES (POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, basic and engineering sciences.

PO3. Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions for complex problems.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling of complex engineering activities with an understanding of the limitations.

PO6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

ABOUT THE DEPARTMENT

The Department of Civil Engineering was established in the year 1960 and is among the oldest departments in the institute. The department runs one undergraduate programme leading to a Bachelor of Technology (B. Tech) degree in Civil Engineering, four postgraduate programmes leading to a Master of Technology (M. Tech) degree in Water Resources Engineering, Structural Engineering, Geotechnical Engineering, and Transportation Engineering & Planning. The department also runs a Ph.D. programme.

VISION AND MISSION OF THE DEPARTMENT

VISION OF THE DEPARTMENT:

To create a unique identity of the Department by achieving excellent standards of quality technical education keeping pace with the rapidly changing technologies and to produce Civil Engineers of global standards with the capability of accepting new challenges.

MISSION OF THE DEPARTMENT:

M1. To promote academic growth in the field of Civil Engineering by offering state-of-the art undergraduate and postgraduate programmes.

M2. To provide knowledge base and consultancy services in all areas of Civil Engineering for industry and societal needs.

M3. To inculcate higher moral and ethical values among the students to become competent Civil Engineers with overall leadership qualities.

M4. To establish the Centre of Excellence in the emerging areas of research related to Civil Engineering and its allied fields.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

PEO1. To produce professionally competent Civil Engineers, capable of applying the knowledge of contemporary Science and Technology, to meet the challenges in the field of Civil Engineering and to serve the Society.

PEO2. To prepare the Civil Engineering graduates to work in industry, government or other organizations in different capacities involving individual and team work.

PEO3. To inculcate among the students the sense of ethics, morality, creativity, leadership, professionalism, self-confidence and independent thinking.

PEO4. To impart the training in problem visualization, surveying, analysis and planning for its solution.

PEO5. To impart training for development of laboratory and design skills, communication skills and skills for software and other modern tool usage among the students.

PEO6. To inculcate in the students the ability to take up the innovative research projects and to conduct investigations of complex Civil Engineering problems using research based methods, thus urging them for higher studies.

PROGRAM SPECIFIC OUTCOME (PSOs):

PSO1. Ability to demonstrate professional engineering approach, including application of principles and utilization of technical resources such as softwares, towards solving technical problems requiring Civil Engineering interventions.

PSO2. Ability to furnish and/or analyze designs and construct structural systems, produce related documents, drawings and reports, and present objective estimates of the related quantities.

PSO3. Ability to conduct field and laboratory investigations pertaining to Civil Engineering domain, and utilize modern tools and techniques.

About 2 years Masters Course in Geotechnical Engineering

The M. Tech. in Geotechnical Engineering is a rigorous two-year postgraduate programme that offers in-depth knowledge and advanced skills in soil mechanics, foundation design, ground improvement, and geotechnical analysis. Blending theory, laboratory work, field studies, and research, the course prepares students to tackle complex geotechnical challenges in real-world projects.

With a focus on innovation, sustainability, and technical excellence, the programme opens doors to careers in infrastructure development, research, consultancy, and higher studies, shaping future experts who build the ground beneath our most critical structures.

This M.Tech programme is more than a degree, it is a transformative journey that shapes professionals capable of designing the foundations of tomorrow's world.

The Program Educational Objectives (PEOs) of M. Tech. in Geotechnical Engineering

The Program Educational Objectives (PEOs)of the Master of Technology programme in Geotechnical Engineering are:

PEO1. The Graduate students will possess advanced expertise in Geotechnical Engineering, empowering them to excel in their professional careers and confidently pursue advanced academic and research opportunities.

PEO2. The Graduate students will demonstrate exceptional communication, technical writing, and interpersonal skills, enabling them to effectively convey complex ideas, collaborate seamlessly across disciplines, and thrive in diverse professional environments.

PEO3. The Graduate students will embody a deep commitment to ethical integrity, uphold the highest standards of quality and performance, champion sustainability, and actively engage in self-directed, lifelong learning to continually advance their professional and personal growth.

Programme Outcomes (POs) of M.Tech. in Geotechnical Engineering

The Programme Outcomes of the Master of Technology programme in Geotechnical Engineering are:

PO1. The Graduate students will develop the ability to independently conduct in-depth research and investigations, applying their findings to devise innovative solutions to real-world challenges.

PO2. The Graduate students will acquire the capability to author and effectively present comprehensive technical reports or documents, demonstrating clarity, precision, and professional rigor in their communication.

PO3. The Graduate students will exhibit a high level of mastery in their chosen area of specialization, reflecting deep subject knowledge and advanced professional competence aligned with the program's focus.

PO4: The Graduate students will cultivate the ability to identify, formulate, and solve complex Geotechnical Engineering problems by leveraging advanced computational techniques and cutting-edge technologies.

PO5: The Graduate students will possess a profound understanding of the broader implications of Geotechnical Engineering solutions, recognizing their impact on global, economic, environmental, and societal dimensions.

PO6: The Graduate students will demonstrate the ability to integrate advanced knowledge of Geotechnical Engineering with management principles, and effectively apply this expertise within multidisciplinary and collaborative environments.

Programme Specific Outcomes (PSOs) of M.Tech. in Geotechnical Engineering

The Programme Specific Outcomes of the Master of Technology programme in Geotechnical Engineering are:

PSO1. The Graduate students will cultivate a mindset of innovation, tackling contemporary challenges with creativity, fostering a strong sense of self-directed learning, and maintaining a commitment to continuous growth in solving complex Geotechnical Engineering problems throughout their careers.

PSO2. The Graduate students will proficiently identify key Geotechnical Engineering challenges related to excavation, geo-environmental concerns, ground improvement, earth-retaining structures, and pavement geotechnics, offering innovative and sustainable solutions to address these issues effectively.

PSO3. The Graduate students will be equipped to make meaningful contributions to multidisciplinary scientific research in Geotechnical Engineering, driving infrastructure growth and development at the State level and advancing National progress..

Potential Graduate Attributes (GA) for Geotechnical Engineering:

The M.Tech in Geotechnical Engineering curriculum is meticulously crafted to align with and cultivate the key Graduate Attributes (GAs) essential for excellence in the field of Geotechnical Engineering. Potential Graduate Attributes (GA) for Geotechnical Engineering are:

1. **Advanced Technical Knowledge**

   The Graduate students will possess in-depth knowledge of Geotechnical Engineering principles and practices, enabling them to address complex engineering challenges.

2. **Research and Problem-Solving Skills**

   The Graduate students will demonstrate the ability to independently conduct research and apply critical thinking to solve real-world Geotechnical Engineering problems.

3. **Communication and Technical Writing Proficiency**

   The Graduate students will excel in communicating complex technical concepts clearly, both in written reports and verbal presentations, to diverse audiences.

4. **Ethical and Professional Responsibility**

   The Graduate students will exhibit a strong commitment to ethical practices, professional integrity, and the responsibility to uphold high standards of quality and sustainability in their work.

5. **Leadership and Teamwork**

   The Graduate students will be able to work effectively in multidisciplinary teams, demonstrating leadership skills while fostering collaboration and innovation in Geotechnical Engineering projects.

6. **Sustainability and Environmental Awareness**

   The Graduate students will understand and consider the long-term impacts of Geotechnical Engineering solutions on the environment and society, striving for sustainable and eco-friendly practices.

7. **Computational and Analytical Skills**

   The Graduate students will be proficient in using advanced computational tools and techniques to analyze and solve complex Geotechnical Engineering issues.

8. **Continuous Learning and Adaptability**

   The Graduate students will foster a commitment to lifelong learning, staying abreast of emerging trends and innovations in Geotechnical Engineering and adapting to new technologies and practices.

9. **Global and Societal Perspective**

   The Graduate students will appreciate the broader context of Geotechnical Engineering solutions, recognizing their global, economic, environmental, and societal impacts.

10. **Innovation and Creativity**

    The Graduate students will cultivate a spirit of innovation, applying creative solutions to contemporary Geotechnical challenges and contributing to the advancement of the field.

11. **Management and Decision-Making Abilities**

    The Graduate students will demonstrate the ability to integrate Geotechnical Engineering knowledge with management principles, making informed decisions in complex and multidisciplinary environments.

12. **Application of Knowledge to Infrastructure Development**

    The Graduate students will contribute to the planning, design, and execution of infrastructure projects, particularly those requiring Geotechnical Engineering expertise, to support state and national development goals.

****

What is the Primary Need and Responsibility of the University Professor of Geotechnical Engineering?

To teach all students the fundamental concepts of saturated-unsaturated soil behavior and thereby teach the students to "think the way saturated-unsaturated soil systems behave"!

****

Course Structure and Syllabus for M.Tech. in Geotechnical Engineering

(2025 BATCH ONWARDS)

SEMESTER – I: AUTUMN SESSION

Course Code		Subjects	L*	T	P	Credit
Core Courses	CGE - 101	Engineering Behavior of soils	2	1	-	3
	CGE - 102	**Analysis and Design of Foundation Systems**	2	1	-	3
	CGE - 103	Soil Exploration and Measurement Techniques	2	1	-	3
	CGE - 104	**Advanced Geotechnical Engineering Laboratory**	-	-	2	1
Elective Courses	**Elective - 1**					
	CGE - 111	**Mechanics of Unsaturated Soils**	2	1	-	3
	CGE - 112	**Underground Excavation in Soils and Rocks**	2	1	-	
	CSE - 103	**Building Information Modelling (BIM)**	2	1	-	
	Elective - 2					
	CGE - 121	**Plasticity and Geotechnics**	2	1	-	3
	CGE - 122	Geosynthetics in Geotechnical Engineering	2	1	-	
	CWE - 111	**Programming for Civil Engineers**	2	1	-	
					Total Credits	**16**

*: L – Lecture, T – Tutorial/Seminar, P – Practical/Studio work

SEMESTER – II: SPRING SESSION

Course Code		Subjects	L*	T	P	Credit
Core Courses	CGE - 201	Critical State Soil Mechanics	2	1	-	3
	CGE - 202	**Soil Dynamics and Machine Foundations**	2	1	-	3
	CGE - 203	Applied Soil Mechanics	2	1	-	3
	CGE - 204	**Soil Dynamics Laboratory**	-	-	2	1
	CGE - 205	Seminar	-	-	2	1
Elective Courses	**Elective - 3**					
	CGE - 211	Geotechnical Aspects of Pavement Design, Construction and Performance	2	1	-	3
	CGE - 212	Advanced Topics and case Studies in Geotechnical Engineering	2	1	-	
	CSE - 201	**Finite Element Analysis**	2	1	-	
	Elective - 4					
	CGE - 221	Environmental Geotechnology	2	1	-	3
	CGE - 222	Soil-Structure Interaction	2	1	-	
	CWE-223	**Applications of AI/ML in Civil Engineering**	2	1	-	
					Total Credits	**17**

*: L – Lecture, T – Tutorial/Seminar, P – Practical/Studio work

SEMESTER – III: AUTUMN SESSION

Course Code		Subjects	L*	T	P	Credit
Core Courses	CGE - 301	Ground Improvement Techniques	2	1	-	3
	CGE - 302	**Frost Geotechnics**	2	1	-	3
	CGE - 303	Dissertation Stage-1	-	-	12	6
Elective Courses		**Elective - 5**				
	CGE - 311	Landfill Engineering	2	1	-	3
	CGE - 312	Earthquake Geotechnical Engineering	2	1	-	
	CGE - 313	**Risk and Reliability Analysis in Geotechnical Engineering**	2	1	-	
	CSE - 303	**Design of Bridge Substructures**	2	1	-	
					Total Credits	**15**

*: L – Lecture, T – Tutorial/Seminar, P – Practical/Studio work

SEMESTER – IV: SPRING SESSION

Course Code	Subjects	L*	T	P	Credit
CGE - 401	Dissertation Stage-II	-	-	24	12
				Total Credits	**12**

Grand Total of Credits = 60

****

Evaluation:

Attendance & Class performance : 24%

Mid-Term Exam : 26%

End-Term Exam : 50%

NOTE:

1. Each Elective Group contains at least one subject of inter-department or of other P.G. areas of the department in order to make the system more flexible and to meet the options of P.G. students of their interest area.
2. Examination of Practicals/Tutorials will be conducted by two internal examiners.
3. One external examiner & concerned internal examiners shall be conducting viva-voce examination in case of Dissertation at Semester IV.
4. Evaluation and examination system for seminar and dissertation will be at par with other P.G. programs of the department.
5. The dissertation involves a detailed study of a Transportation related, problem (actual field/ research) which a student has to carry out under the supervision of one of the faculty members of the Department. The dissertation work can also be of interdisciplinary nature with transportation element involved.
6. Part-time students will be eligible to take up the 3rd semester regular in their 5th semester, only when they have successfully completed the 1st and 2nd semesters.

Existing Faculty Position

1. Prof. B. A. Mir, Professor, M.E. (Geotechnical Engineering) IISc Bangalore, Ph. D. IIT Bombay
2. Prof. M. Y. Shah, Professor, M. Tech. (Geotechnical Engineering) IIT Delhi, Ph.D. IIT Roorkee
3. Dr. Majid Hussain, Assistant Professor, B. Tech NIT Srinagar, Ph.D. (Geotechnical Engineering) IIT Gandhinagar
4. Dr. Rajesh P. Shukla, Assistant Professor, M. Tech (Geotechnical Engineering) IIT Kanpur, Ph.D. IIT Roorkee
5. Dr. Ritesh S. Ingale, Assistant Professor, M. Tech (Geotechnical Engineering) S.V. NIT Surat, Ph.D. V. NIT Nagpur
6. Dr. Falak Zahoor, Assistant Professor, B. Tech NIT Srinagar, Ph.D (Geotechnical Engineering) IIT Delhi

****

Allotment of Elective Course

The choice of the elective courses is primarily based on the interest of the students. Faculties offering the respective elective subject interact with all students and brief out the content with relevance of the subject in field or in research. On the basis of merit, students are given the freedom to select the elective of their choice. Emphasize is made to offer maximum number of electives in each semester, however, at least 5 students need to opt a certain elective to run it.

UPDATED SYLLABUS (2025)

REVISED SYLLABUS FOR M. TECH. GEOTECHNICAL ENGINEERING

(EFFECTIVE: 2025 BATCH ONWARDS)

1ST SEMESTER

A: CORE COURSES (2025 Batch Onwards)

1. CGE - 101: ENGINEERING BEHAVIOUR OF SOILS

	L	T	P	C
SEMESTER: 1ST	**L**	**T**	**P**	**C**
COURSE NO. CGE - 101	**2**	**1**	**0**	**3**

1. Subject Area ` : **Civil Engineering**
2. Subject Title : **Engineering Behavior of Soils**
3. Subject Code : CGE-101
4. Contact Hours : L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]
5. Credits : 3
6. Semester/Session : **1ST** (Autumn Session)
7. Examination Duration (Hrs) : Mid-Term Exam = 1.25 minutes; End-Term Exam = 2.5
8. Evaluation Weightage (Marks) : C. P. = 24; End-Term = 26 & End-Term = 50
[C. P. = Class performance, which includes attendance, Assignments and interaction in the class]
9. Pre-requisite : **Geotechnical Engineering**
10. Objective: To impart understanding of Application of Soil Mechanics Theories in the field of Civil Engg.
11. Course Details -as in tabular form below:

Unit No.	Course Contents	Contact Hours
1	• Origin and nature of Soils: Mineralogy, Distribution of soils, Clay – water - electrolytes system. Soil fabric, soil structure and Engg. Classification of soils. • Introduction to Scanning Electron Microscopy (SEM), Imaging with the SEM, Energy Dispersive X-ray Spectroscopy (EDS or EDX), Fourier Transform Infrared Spectroscopy (FTIR), X-Ray Diffraction Methods, Diffraction Analysis, Specimen Preparation, The Concept of Microstructure, Comparative Performance of Transmission and Scanning Electron Microscopy • Description of state of stress and strain at a point; Development of rheological models and equations of state for soils; Stress distributions, problems in elastic half-space, Boussinessqu, Westergard Mindlin and Kelvin problems, Distribution of contract pressure.	14
	• Strength Behavior: Effective stress principle: Triaxial tests and applications. Types of tests based on drainage conditions and their practical significance, Shear strength parameters.	

2	• Engineering Behavior of different Soils, Shear strength of unsaturated soils, Factors affecting Strength: Structure and texture, porosity, confining pressure, Stress history, Degree of saturation, Anisotropy, Intermediate principal stress. • Introduction to Critical State Soil Mechanics: Stress paths and p-q plots, Constitutive Models in Soil Mechanics, Rendulic Henkel plot, Taylor's plot, Hvorslev's parameters.	16
3	• Fundamental concepts of consolidation: Primary and secondary compression; One, two- and three-dimensional problems • Determination of preconsolidation pressure; Consolidation of partially saturated soils; Settlement computations. • Influence of test parameters on results, Consolidation test, Triaxial consolidation, Anisotropic, K consolidation, Radial consolidation, Layered soil system	12
	Total Contact Hours	**42**

COURSE TEXTBOOK: **Some useful resources are:**

1 J K Mitchal & Kenichi Soga (2005). Fundamentals of Soil Behavior, *John* Wiley & Sons, New York

2 Kasmalkar, B. J. (1997). Geotech. Engineering. Pune Vidyarthi Griha Prakashan-1786, Sadashiv Peth, Pune-411030.

3 Kasmalkar, B. J. (1997). Foundation. Engineering. Pune Vidyarthi Griha Prakashan-1786, Sadashiv Peth, Pune-411030.

4 Murthy, V. N. S. (2013). Soil Mechanics & Foundation Engg, CBS publishers & distributors, 4819/XI, 24 Ansari Road, Daryaganj, New Delhi-002

5 Das, Braja M. (1999). Advanced Soil Mechanics. PWS Publishing, Pacific Grove, Calif.

6 Karl Terzaghi, Theoretical Soil Mechanics, Chapman and Hall

7 Karl Terzaghy, Ralph B. Pech & Gholamreza Mesri (1996). Soil Mechanics in Engg. Practice, *John* Wiley & Sons, New York

8 R.F. Scott, Principles of Soil Mechanics, Addison Wesley, World Student Edition

9 M.G.Sprangler, Soil Engineering

10 Proceedings of the International Conferences on Soil Mechanics and Foundation Engineering on Shear Strength of soils (1963).

11 Gopal Ranjan & ASR Rao (2000). Basic ans Applied Soil Mechanics, New Age Int`l Publishers New Delhi 002

12 Arpad Kezdi (1974). Handbook of Soil Mechanics, Vol. 1 & 2, Elsevier, Newyark

13 David F. McCarthy (2007). Essentials of Soil Mechanics & Foundations: Basic Geotechnics (7/E), Prentice-Hall, New Jersey, Columbus, Ohio

14 Roy E. Hunt (1986). Geotechnical Engg Analysis & Evaluation, McGraw-Hill, New Delhi

15 K. H. head (2006). Manual of Soil Laboratory Testing: Vol.I-III, Whittles Publishing, CRC Press, UK

****

2. CGE - 102: Analysis and Design of Foundation Systems

	L	T	P	C
SEMESTER: 1ST	**L**	**T**	**P**	**C**
COURSE NO. CGE - 102	**2**	**1**	**0**	**3**

1. Subject Area : **Civil Engineering**

2. Subject Title : **Analysis and design of Foundation Systems**

3. Subject Code : CGE-102

4. Contact Hours : L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]

5. Credits : 3

6. Semester/Session : **1ST** (Autumn Session)

7. Examination Duration (Hrs) : Mid-Term Exam = 1.25 minutes; End-Term Exam = 2.5

8. Evaluation Weightage (Marks) : C. P. = 24; End-Term = 26 & End-Term = 50
[C. P. = Class performance, which includes attendance, assignments and interaction in the class]

9. Pre-requisite : **Geotechnical Engineering**

10. Objective: To impart understanding of various aspects related to Foundations in the field of Civil Engg.

11. Course Details -as in tabular form below:

Sr. No.	Course Contents	Contact Hours
1	• **Introduction to Foundation Engineering:** • Principles of foundation Engineering, challenging problems, Design requirements/ information needed for foundation design. • Classification of foundations (Flexible, rigid, shallow and deep foundations). • **Terminology involved in Foundation Analysis and Design:** Gross bearing capacity, ultimate bearing capacity, net-ultimate bearing capacity, safe bearing capacity, net safe bearing capacity, safe bearing pressure, allowable bearing pressure. • **Design Criteria for Foundation Design:** Location and depth criteria, shear failure criteria (safe bearing capacity criteria), settlement criteria (safe bearing pressure criteria). • **Factors for Selection of Type of Foundation:** Function of the structure and the loads it must carry, sub-surface condition of the soil, cost of super-structure.	6
2	• **Basic Design parameters for safe foundation design:** • Service loads (DL, LL, WL, EQL, SL, etc and their combination and reduction factors) • Safe bearing capacity, soil pressure on foundation, size of footing (structural design by limit state design as in case of other RC members) • Conventional analysis of foundations subjected to vertical loads and moments • Thickness of footing and its requirements, minimum reinforcement requirement (IS:456)	6

4	• **Design of Shallow and Raft/Mat Foundations:** • Principles of foundation design, Basic design of shallow foundations subjected to eccentricity • Need for Raft foundations and design methods • Design of Mat Foundations on problematic soils, Settlement of shallow foundations	6
	• **Axial Load Capacity of Piles and Pile Groups:** • Allowable load of piles and pile groups – Static and dynamic methods – for cohesive and cohesionless soil • Negative skin friction – group efficiency – pile driving formulae - limitation – Wave equation application • Interpretation of field test and pile load test results, settlement of piles and pile group - codal provisions.	8
	• **Lateral and Uplift Load Evaluation of Piles:** • Piles under Lateral loads – Broms method, elastic, p-y curve analyses • Batter piles – response to moment – piles under uplift loads under reamed piles – Drilled shaft – Lateral and pull out load tests – codal provision studies.	6
	• **Caissons:** Necessity of caisson – type and shape – Stability of caissons – principles of analysis and design – tilting of caisson – construction - seismic influences – codal provision.	4
5	• **Settlement analysis of Piles:** t-z method, Pile load tests, Foundations on expansive and collapsible soils • **Design of Pile and Pile Groups:** Design of pile, structural capacity, pile and pile cap connection, pile cap design, reinforcement details of pile and pile caps, pile raft system, basic interactive analysis – pile subjected to vibration –codal provision.	06
	Total Contact Hours	**42**

Books Recommended:

1. Kurian, N.P (1994). Design of Foundation Systems: Principles & Practices, Narosa publishing House, New Delhi.
2. Kurian, N. P. (1984). Modern Foundations – Introduction to Advanced Techniques, Tata McGraw-Hill Publishing Company Limited New Delhi.
3. Kasmalkar, J.B. (1997). Foundation Engineering, Pune Vidyarthi Graha Prakashan-1786, Pune-411030.
4. Bowels, Joseph E.(1996). Practical Foundation Engineering Handbook. 5th edition, McGraw-Hill, New York.
5. Das, Braja M. (1999). Principles of foundation Engineering, 4th edition, PWS publishing, Pacific Grov. Calif.
6. Peck, Ralph B., Hansen, Walter E., and Thornburn, Thomas H. (1974). Foundation Engineering. John Wiley & Sons, New York.
7. Praksh, Shamsher, and Sharma, Hari D. (1990). Pile foundation in Engineering Practice, John Wiley & Sons, New York.
8. Som, N.N., and Das, S.C. (2003). Foundation Engineering: Principles and Practice. Prentice –Hall of India Pvt. Ltd. New Delhi-001.
9. Varghese, P.C. (2005). Foundation Engineering Prentice –Hall of India Pvt. Ltd. New Delhi
10. Tomlonson, Michael J. (1995). Foundation Design and Construction. John Wiley & Sons, New York.

****

3. CGE – 103: Soil Exploration and Measurement Techniques

	L	T	P	C
SEMESTER: 1ST	**L**	**T**	**P**	**C**
COURSE NO. CGE - 103	**2**	**1**	**0**	**3**

1. Subject Area : **Civil Engineering**
2. Subject Title : **Soil Exploration and Measurement Techniques**
3. Subject Code : CGE-103
4. Contact Hours : L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]
5. Credits : 3
6. Semester/Session : **1ST** (Autumn Session)
7. Examination Duration (Hrs) : Mid-Term Exam = 1.25 minutes; End-Term Exam = 2.5
8. Evaluation Weightage (Marks) : C. P. = 24; End-Term = 26 & End-Term = 50
[C. P. = Class performance, which includes attendance, assignments and interaction in the class]
9. Pre-requisite : **Geotechnical Engineering**
10. Objective: To impart understanding of various aspects related to soil exploration and measurement techniques.
11. Course Details -as in tabular form below:

Unit No.	Course Contents	Contact Hours
1	**Introduction:** general principles of exploration; objectives, stages, and scope of investigation; planning and procurement; general design philosophy; planning ground investigations. **Exploration:** objectives; surface mapping (terrain analysis; remote sensing; reconnaissance survey; preparation of subsurface exploration program); exploration methods (boring, drilling, probing and trial pitting), different types of borings; sampling methods (surface sampling, sampling from boreholes and core boring in soils); sample disturbance; preservation and transportation of samples; undisturbed sampling techniques (samples from pits and exposures, drive samplers, rotary samplers, sand sampling, sampler selection); investigation below sea/river bed; offshore investigation; rock coring; boring and sampling records; soil profile; interpretation of exploration data and report preparation.	12
2	**In-situ field tests:** plate load test; pile load test; cone penetration test; dynamic cone penetration test; standard penetration test; becker penetration test; field vane shear test; pressuremeter test; dilatometer test; suspension logging test. **Geophysical exploration:** principles and limitations of geophysical exploration methods; geophysical data processing (digitization, spectral analysis, waveform processing, digital filtering, imaging and modeling); elements of seismic surveying; seismic reflection surveying; seismic refraction surveying; spectral analysis of surface waves method; multichannel analysis of surface waves method; gravity surveying; magnetic surveying; electrical resistivity surveying; electro-magnetic surveying; radiometric surveying; microtremor (HVSR) surveying method; ground penetration radar; integrated geophysical problems; geophysical borehole logging.	12

3	**Basic field instrumentation**: uses and requirements of field instrumentation; in-situ pressures and stresses (pore pressure measuring devices; load and stress measuring devices; earth pressure cells; residual rock stresses); ground water level measurement; subsurface deformation measurement (vertical and lateral displacement measurement; linear strain gradients; acoustic measurements) and settlement measurements; vibration monitoring; instrumentation arrays for typical problems (pickups and generators for vibration study of machine foundations; measurement of movements in dams; excavation retention; fault movements; cut slopes; tunnels, caverns, and mines).	12
4	**Introduction to Methods of Microstructural Characterization of Soils:** Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Spectroscopy (EDS or EDX), X-ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), Mercury Intrusion Porosimetry (MIP), Thermogravimetric Analysis (TGA/DTG), BET Analysis (Nitrogen Adsorption).	06
	Total Contact Hours	42

References:

1. Bowles, J. E, Physical and Geotechnical Properties of Soil, McGraw-Hill Book Company, 1985.
2. Bowles, J. E, Foundation Analysis and Design, McGraw-Hill International edition, 1997.
3. Dunnicliff, J. and Green, G. E, Geotechnical Instrumentation for Monitoring Field Performance, John Wiley & Sons, 1982.
4. Gopal Ranjan and Rao, A. S. R, Basic and Applied Soil Mechanics, Wiley Eastern Limited, 1991.
5. Lunne, T., Robertson, P. K. and Powell, J. J. M, Cone Penetration Testing in Geotechnical Practice, Blackie Academic & Professional, 1997.
6. Compendium of Indian Standards on Soil Engineering Parts 1 and II 1987 - 1988.
7. Patrick Echlin (2009). Handbook of Sample Preparation for Scanning Electron Microscopy and X-Ray Microanalysis. © Springer Science+Business Media, LLC 2009.
8. David Brandon and Wayne D. Kaplan (2008). Microstructural Characterization of Materials. John Willey & Sons

****

4. CGE - 104: Advanced Geotechnical Engineering Laboratory

	L	T	P	C
SEMESTER: 1ST	**L**	**T**	**P**	**C**
COURSE NO. CGE - 104	**0**	**0**	**2**	**1**

Geotechnical Lab (with advanced experiments focusing on permeability, compressibility, Shear Strength and Freeze-Thaw characteristics of soils)

****

B. ELECTIVE COURSES: ELECTIVE – E1

1. CGE-111. Mechanics of Unsaturated Soils

SEMESTER: 1ST	**L**	**T**	**P**	**C**
COURSE NO. CGE - 111	**2**	**1**	**0**	**3**

1. Subject Area : **Civil Engineering**
2. Subject Title : **Mechanics of Unsaturated Soils**
3. Subject Code : CGE-111
4. Contact Hours : L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]
5. Credits : 3
6. Semester/Session : **1ST** (Autumn Session)
7. Examination Duration (Hrs) : Mid-Term Exam = 1.25 minutes; End-Term Exam = 2.5
8. Evaluation Weightage (Marks) : C. P. = 24; End-Term = 26 & End-Term = 50
[C. P. = Class performance, which includes attendance, assignments and interaction in the class]
9. Pre-requisite : **Geotechnical Engineering**
10. Objective: To impart understanding of various aspects related to unsaturated soil Engineering practice in the field of Civil Engg.
11. Course Details -as in tabular form below:

Unit No.	Course Contents	Contact Hours
1	• Introduction to Unsaturated soils: Definitions, notations and unsaturated soil framework, Unsaturated Soil Mechanics In Engineering Practice • Nature and phase properties of unsaturated soil • Stress State Variables for Unsaturated Soils, Effective stress concepts, Matric and osmotic suction • Measurement and Estimation of Stress State Variables	12
2	• Identification and classification of expansive soils • Identification and classification of collapsing soils • Fundamentals of Soil Volume Changes and Volume Change Behavior • Soil-Water Characteristic Curves for Unsaturated Soils, Water Flow Through Unsaturated Soils	16
3	• Air Flow Through Unsaturated Soils, Ground Surface Moisture Flux Boundary Conditions • Shear Strength and Deformation Characteristics of Unsaturated Soils	06
4	• Laboratory determination of swell pressure, swell potential • Laboratory determination of collapse potential and soil suction	08
	Total Contact Hours	**42**

Books Recommended:

1. Kasmalkar, J.B. (1997). Geotechnical Engineering, Pune Vidyarthi Graha Prakashan-1786, Pune-411030.
2. D. G. Fredlund, H. Rahardjo, M. D. Fredlund (2012). Unsaturated Soil Mechanics in Engineering Practice, John Wiley & Sons, Inc
3. G.E. Blight and E.C. Leong (1997). Mechanics of Residual Soils, CRC Press Taylor & Francis Group.
4. Azad Koliji (2008). Mechanical Behavior of Unsaturated Aggregated Soils
5. Jhon, D. and Miller, D. J. (1992). Expansive soils-Problems and practice in foundation and pavement Engineering, John Wiley & Sons, Inc

****

2. CGE-112. Underground Excavation in Soils and Rocks

	L	T	P	C
SEMESTER: 1ST	**L**	**T**	**P**	**C**
COURSE NO. CGE – 112	**2**	**1**	**0**	**3**

1. **Subject Area** : **Civil Engineering**
2. **Subject Title** : **Underground Excavation in Soils and Rocks**
3. Subject Code : CGE-112
4. Contact Hours : L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]
5. Credits : 3
6. Semester : Autumn Session
7. Examination Duration (Hrs) : Mid-Term Exam = 1.25 minutes; End-Term Exam = 2.5
8. Evaluation Weightage (Marks) : C. P. = 24; End-Term = 26 & End-Term = 50
   [C. P. = Class performance, which includes attendance, assignments and interaction in the class]
9. Pre-requisite : **Nill**
10. Objectives:
11. Course Details -as in tabular form below:

Sr. No.	Contents	Contact Hours
1	Classification: Classification of soils, rock and rock masses, Engineering properties of Rock and their measurement.	6
2	Stresses in soils and rocks: State of stress in the ground, In-situ stress, various methods of stress measurement, Hydrofracturing technique, Flat jack technique, Overcoring technique.	6
3	Failure Theories in soils & rocks: Failure criteria for rock and rock masses, Mohr-Coulomb Yield Criterion, Hoek-Brown Criterion, Tensile Yield Criterion, Strength of discontinuities.	6
4	Foundations on Rocks: Underground openings and support system, Design of foundation system	8
5	Stress distribution around openings: Stresses distribution around single openings, Stress distribution around multiple openings, Stresses and deformations around	8

	tunnels and galleries with composite lining due to internal pressure.	
6	Design of underground openings: Design based on empirical methods such as RSR, RMR, Q systems, Design based on Rock support interaction analysis, Observational method- NATM, Convergence-confinement method, Key block analysis, Stability of excavation face and Tunnel portals.	8
	Total Contact Hours	**42**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Learn the methods to make assessment of the properties of rock and rock masses

CO2: Learn the design of underground openings in varying ground conditions

Books and References

1. Introduction to Rock Mechanics by Richard E. Goodman, John Wiley & Sons Inc.
2. Underground excavation in rock by Hoek, E. and Brown, E. T., Institution of Mining and Metallurgy, 1982.
3. Engineering Rock Mechanics: An Introduction to the Principles by J. A. Hudson & J.P. Harrison, Elsevier Science & Technology.
4. Rock Characterization, Testing and Monitoring by Brown, E. T, Pergamon Press, 1986.
5. Stresses in Rocks by Herget, G,, Balkema, 1988.
6. Engineering Rock Mass Classification by Bieniawski, Z. T,, John Wiley and Sons, 1989.
7. Foundations on Rock by Wyllie, D. C,, E & FN Spon. 2nd Edition, 1992.
8. Introduction to Tunnel Construction by Champion, D., Metje, N. and Stark, A.
9. Tunnel Engineering Handbook by Bickel, J. O, Kuesel, T. R. and King, E. H.

10. The Art of Tunnelling by K.Szechy,, Tesa, 1960

****

3. CSE-103. Building Information Modelling (BIM)

SEMESTER: 1ST	**L**	**T**	**P**	**C**	**(Str Engg Faculty)**
COURSE NO. CSE – 103	**2**	**1**	**0**	**3**	

1. Subject Area	**: Civil Engineering**
2. Subject Title	: **Building Information Modelling (BIM)**
3. Subject Code	: CSE-103
4. Contact Hours	: L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]
5. Credits	: 3
6. Semester/Session	: **1ST** (Autumn Session)
7. Examination Duration (Hrs)	: Mid-Term Exam = 1.25 minutes; End-Term Exam = 2.5
8. Evaluation Weightage (Marks)	: C. P. = 24; End-Term = 26 & End-Term = 50
	[C. P. = Class performance, which includes attendance,

assignments and interaction in the class]

9. Pre-requisite : **Nill**

10. Objectives:

11. Course Details -as in tabular form below:

Sr. No.	Contents	Contact Hours
1	• **Overview of BIM:** BIM introduction, importance and benefits of BIM in the construction industry, BIM workflows • **BIM Levels & Dimensions:** BIM Levels, concepts and applications, key BIM dimensions, nD modelling, Understanding LOD through BIM components	10
2	• **Collaboration and Interoperability:** data exchange methods and standardization, BIM for managers and clients, BIM for engineers and architects, BIM for contractors and builders, BIM for manufacturers and sub-contractors • **Integration**: Applications of Internet of Things (IoT), BIM with Artificial intelligence, virtual reality and augmented reality with BIM,	10
3	• **Adoption and implementation:** Significance of BIM mandate by government, Motivations, Requirements, BIM education and training, Issue related to legal perspective, intellectual property, Cyber security, existing practices and social problems	8

4	• **BIM Modelling using Autodesk Revit:**
	  • **Structural Modelling:** Introduction to Revit Structural Module, Modeling structural elements (Beams, Columns, Slabs, Wall, Foundations), Basic and advanced modeling techniques for structures
	  • **Coordination of structural and Architectural Models:** Linking and coordinating structural models with architectural models, Identifying and resolving inconsistencies
	  • **Cost Estimation, Detailing, and Documentation:** Generating cost estimations using schedules in Revit, Customization of cost estimation reports, Detailing of structural components (e.g., annotations, callouts, and section details), Preparation and customization of project documentation
	  • **Introduction to Clash Detection:** Concept of clash detection and its role in reducing errors, Introduction to Revit's Interface Check for clash detection
		14

	Total Contact Hours	**42**

Text Books:

1. Issa, R.R. and Olbina, S. eds., 2015, May. Building information modeling: applications and practices. American Society of Civil Engineers.
2. Nawari, N.O. and Kuenstle, M., 2015. Building information modeling: Framework for structural design. CRC Press.
3. An Introduction to Building Information Modelling, by The Institution of Structural Engineers BIM Panel, 2021
4. Building Information Modelling – BIM, Construction Managers Library, ERASMUS+ Programme, Warsaw, Iceland, Great Britain, 2017

References:

1. **BIM Handbook:** A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers

Autodesk Revit User Manual and official tutorials

****

ELECTIVE COURSES: ELECTIVE - E2

1. CGE-121. Plasticity and Geotechnics

	L	T	P	C
SEMESTER: 1ST	**L**	**T**	**P**	**C**
COURSE NO. CGE – 121	**2**	**1**	**0**	**3**

1. Subject Area : **Civil Engineering**

2. Subject Title : **Plasticity and Geotechics**

3. Subject Code : CGE-121

4. Contact Hours : L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]

5. Credits : 3

6. Semester/Session : **1ST** (Autumn Session)

7. Examination Duration (Hrs) : Mid-Term Exam = 1.25; End-Term Exam = 2.5

8. Evaluation Weightage (Marks) : C. P. = 24; End-Term = 26 & End-Term = 50
[C. P. = Class performance, which includes attendance, assignments and interaction in the class]

9. Pre-requisite : **Nill**

10. Objectives:

11. Course Details -as in tabular form below:

Unit No.	Course Contents	Contact Hours
Unit -1	**Foundations of Soil Plasticity and Stress-Strain Behavior** • Stress and strain in soil elements: invariants, stress paths, and octahedral stresses • Elastic behavior: isotropic and anisotropic elasticity, stiffness matrix • Concepts of plasticity: elastic-plastic decomposition, yield surface • Failure criteria: Mohr-Coulomb, Drucker-Prager, Tresca, and von Mises • Flow rules: associated and non-associated flow, plastic potential, dilatancy • Hardening rules: isotropic, kinematic, and combined • Theorems of plastic collapse for limit analysis	14

Unit - 2	**Constitutive Relations** • Elastic models: linear and nonlinear elasticity • Perfect plasticity models for cohesive soils: Tresca and von Mises • Perfect plasticity models for frictional materials: Mohr-Coulomb, Drucker-Prager, Lade-Duncan, Matsuoka-Nakai, Hoek-Brown • Isotropic hardening and critical state theory • Unified critical state models: CASM • Extensions of CASM: shear hardening, viscoplasticity, unsaturated soils, bonded geomaterials • Multi-surface plasticity models for soils • Bounding surface models and unified bounding surface models	14
Unit - 3	**Geotechnical Applications** • Slip line analysis • Bearing capacity of embankments: stress fields, velocity fields, hill's mechanisms • Solutions for a general anisotropic cohesive-frictional material and cohesive materials • Basic procedures of limit analysis • Procedures of nonlinear finite element analysis	14
	Total Contact Hours	**42**

Suggested Books:

1. Yu, H. S. (2007). Plasticity and geotechnics (Vol. 13). Springer Science & Business Media.
2. Davis, Robert Olin, and Antony PS Selvadurai. Plasticity and geomechanics. Cambridge university press, 2005.
3. Khan, A. S., & Huang, S. (1995). Continuum theory of plasticity. John Wiley & Sons.
4. Borja, R. I. (2013). Plasticity. Springer Berlin Heidelberg. doi, 10(1007), 978-3.
5. Hai-Sui Yu (2006). , UKPlasticity And Geotechnics. © 2006 Springer Science-fBusiness Media, LLC, USA
6. R. O. Davis & A. P. S. Selvadurai (2002). Plasticity and Geomechanics. Cambridge University Press The Edinburgh Building, Cambridge, United Kingdom

****

2. CGE-122. Geosynthetics in Geotechnical Engineering

	L	T	P	C
SEMESTER: 1ST	**L**	**T**	**P**	**C**
COURSE NO. CGE – 122	**2**	**1**	**0**	**3**

1. Subject Area : Civil Engineering
2. Subject Title : Geosynthetics in Geotechnical Engineering
3. Subject Code : CGE-122
4. Contact Hours : L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]
5. Credits : 3
6. Semester/Session : **1ST** (Autumn Session)
7. Examination Duration (Hrs) : Mid-Term Exam = 1.25; End-Term Exam = 2.5
8. Evaluation Weightage (Marks) : C. P. = 24; End-Term = 26 & End-Term = 50
[C. P. = Class performance, which includes attendance, assignments and interaction in the class]
9. Pre-requisite : **Nill**
10. Objectives:
11. Course Details -as in tabular form below:

Course Details

Sr. No.	Contents	Contact Hours
1	Geosynthetics: Definitions and classification, Basic functions and selection, Historical development, Raw materials and manufacturing processes, Properties and test methods, Standards and Codes of Practice.	12
2	Soil-geosynthetic interaction: Application areas – retaining walls, Embankments, Shallow foundations, Unpaved roads, Paved roads, Airport, Railway tracks, Slopes, Landfills, Earth dams, Containment ponds, Reservoirs, Ponds, Canals, Pipeline and drainage systems, Tunnels.	16
3	Seismic aspects of geosynthetic applications; Quality control and *in-situ* monitoring; Cost analysis; Case Histories.	14
	Total Contact Hours	**42**

References:

1. Clayton, C. R. I., Milititsky, J. and Woods, R. I., Earth Pressure and Earth Retaining Structures, Blackie Academic & Professional, 1993.
2. Ingold, T, Reinforced Earth, Thomas Telford Ltd., 1982.
3. Jones, C. J. F. P, Earth Reinforcement and Soil Structures, Butterworth, 1985.
4. Koerner, R. M, Designing with Geosynthetics, Prentice Hall, 1993.

****

3. CWE-111. Programming for Civil Engineers

SEMESTER: 1ST	**L**	**T**	**P**	**C**	**(WRE Faculty)**
COURSE NO. CWE - 111	**2**	**1**	**0**	**3**	

1. Subject Area : **Civil Engineering**

2. Subject Title : **Programming for Civil Engineers**

3. Subject Code : CWE-111

4. Contact Hours : L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]

5. Credits : 3

6. Semester/Session : **1ST** (Autumn Session)

7. Examination Duration (Hrs) : Mid-Term Exam = 1.25hrs; End-Term Exam = 2.5hrs

8. Evaluation Weightage (Marks) : C. P. = 24; End-Term = 26 & End-Term = 50
[C. P. = Class performance, which includes attendance, assignments and interaction in the class]

9. Pre-requisite : **Nill**

10. Objectives: Data analysis is among the most growing tools desired in many engineering fields, including Civil Engineering. The course aims to develop programming skills in Civil Engineering students using two open-access data analysis-oriented languages R and Python.

11. Course Details -as in tabular form below:

S. No.	Content	Contact Hours
1	**R (Use R!):** Introduction to RStudio: Installing RStudio, overview, packages, getting Help.	2
2	Data Types: R Objects and attributes, vectors and lists, matrices; factors; data frames, dates and times; reading tabular data; Sub-setting and Operations. Some practical applications.	6
3	Control Structures - Introduction; choices and loops, Loop functions: lapply; mapply; tapply; Some examples.	6
4	Functional Programming: Introduction, scoping Rules; coding standards; piping; Practical applications; Some packages for Civil Engineers.	8
5	Debugging: Introduction; general techniques, locating errors, interactive and non-interactive debugging.	2
6	**Python:** Introduction: installation Anaconda and overview, libraries, and getting help.	2
7	Data types and structures: strings, scalers, vectors, matrices, lists, reading tabular data, Numpy and Pandas.	4
8	Control structures: Introduction, choices and loops; Some examples.	4
9	Functional Programming: functions, scoping, and classes; Some libraries for Civil Engineers; Debugging rules and ideas.	6
10	Introduction to Matlab.	2
	Total Contact Hours	**42**

Suggested Books:

1. R for Data Science: Import, Tidy, Transform, Visualize, and Model Data/ Hadley Wickham, Garret Grolemund/O'Reilly Media/1st Edition (2017).
2. Advanced R/Hadley Wickham/ Chapman & Hall/CRC/ Second Edition (2019).
3. Introduction to Computation and Programming Using Python/ John V. Guttag/ MIT Press/Second Edition(2016).

****

SEMESTER – II: SPRING SESSION

A: CORE COURSES (2025 Batch Onwards)

1. CGE-201. Critical State Soil Mechanics

	L	T	P	C
SEMESTER: 2ND	**L**	**T**	**P**	**C**
COURSE NO. CGE - 201	**2**	**1**	**0**	**3**

1. Subject Area : **Civil Engineering**
2. Subject Title : **Critical State Soil Mechanics (CSSM)**
3. Subject Code : CGE-201
4. Contact Hours : L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]
5. Credits : 3
6. Semester/Session : 2ND Sem. (Spring Session)
7. Examination Duration (Hrs) : Mid-Term Exam = 1.25; End-Term Exam = 2.5
8. Evaluation Weightage (Marks) : C. P. = 24; End-Term = 26 & End-Term = 50
[C. P. = Class performance, which includes attendance, assignments and interaction in the class]
9. Pre-requisite : **Geotechnical Engineering**
10. Objectives: To introduce the basic critical state frame work to interpret soil behavior under different stress path conditions.
Critical State Soil Mechanics course provides students/learners with a comprehensive look at critical state soil mechanics and its application in geotechnical engineering. The course covers important aspects such as stress invariants and stress paths, while exploring the concept and application of a state boundary surface to describe the behaviour of normal and overconsolidated soil.
11. Course Details -as in tabular form below:

Unit No.	Course Contents	Contact Hours
Unit -1	**Introduction to Critical State Soil Mechanics (CSSM)** • An introduction to Geotechnical Engineering, Classical Soil Mechanics, Modern Soil Mechanics, Critical State Soil Mechanics. • Need for Critical State Soil Mechanics (CSSM): Classical soil mechanics analysis vs Critical state soil mechanics analysis, Definition of Critical State Concept, Critical State Line of Soils, Types of State Boundary Surfaces (SBSs), The State of a Saturated Soil, Critical State parameters. **Material behavior and Stress Path Analysis in Soils** • Fundamentals of stress and strain in soils, Stress and strain invariants; mean stress, deviatoric stress, volumetric and deviatoric strains, Axisymmetric and plane strain conditions, Generalized Hooke's law using stress-strain invariants. • One-dimensional and isotropic compression behavior of soils, Idealized soil	12

	compression and state boundary surface, Soil testing under drained and undrained conditions. • Stress Path Methods: Stress paths, Characteristics of Stress Path Plots, Concepts and plotting methods using stress invariants and 2D stress parameters	
Unit - 2	**Critical State Framework and Constitutive Models** • Constitutive equations/ Soil Models: Overview of Soils Models and Constitutive Model, Requirements of Constitutive Models, Development of Soil Models, Important Aspects of Selecting a Constitutive Model, Soil Models and their aspects, limitations & input parameters, Evaluation of Constitutive Models, Description of the Most commonly used Models. • Introduction to the critical state concept and critical state line (CSL), p'-q-v space and its interpretation, Roscoe surface and Hvorslev surface • Critical state behaviour of clays, sands, and other granular materials, Behaviour of soils before failure and in overconsolidated states. • Cam Clay model predictions for drained and undrained triaxial compression. • Modified and Original Cam Clay models: elastic-plastic formulation. • Yield surfaces and hardening rules, Stress-dilatancy, plastic flow, flow rules, and Rowe's stress-dilatancy relation	14
Unit - 3	**Parameter Determination and Engineering Applications** • Modeling of soil behavior using Critical state theory: The Modified Cam-C1ay Model- Reconstituted soil samples, Laboratory tests and data interpretation, Determination of critical state parameters (e.g., M, λ, κ, Γ) from laboratory test data • Total and effective stress analysis within the critical state framework, undrained shear strength and pore pressure response at failure, Peak strength and post-peak behaviour. • Compression Behaviour of Soils: Stress Paths within and on the State Boundary Surface during a Triaxial Tests- Undrained/drained shear test on NC/OC clay/sand. • The Critical State line and Roscoe Surface, Hvorslev Surface, Rendulic Henkel plot, Taylor's plot. • Overview of advanced constitutive models (e.g., NorSand, MIT-S1) • Application of critical state models in geotechnical problems: slope stability, foundations, embankments, Interpretation of index properties and standard soil tests using critical state principles, Implementation in numerical analysis and limitations of critical state theory.	16
	Total Contact Hours	**42**

PROGRAMME/ COURSE OUTCOMES (POCS) - AT THE END OF THIS COURSE

At the end of this course, the students will able to:

- POCS1: Have a thorough understanding of the critical state concept and its application in geotechnical engineering?
- POCS2: Have a thorough understanding of Stress invariants, stress paths and the state boundary surface
- POCS3: Have a thorough understanding of Plasticity theory and the Cam Clay model in geotechnical engineering research, and
- POCS4: Students should be able to model the input and judge the output of a specific FE code for soils constitutive modeling.

Recommended References:

- Atkinson, J. H.: The Mechanics of Soils & Foundations. Taylor and Francis, New York
- Schofield, A. N.: Critical State Soil Mechanics. McGraw-Hill London
- Wood, D. M.: Soil Behavior and Critical State Soil Mechanics. New York.
- Wood, D. M.: Geotechnical Modelling. CRC Press; 1st edition (22 July 2004)
- Parry, R. H. G.: Mohr Circles, Stress Paths and Geotechnics. Spon Press, London.
- Ortigao, J. A. R.: Soil Mechanics in the Light of Critical State Theories: An Introduction. Balkema, The Netherlands.
- Bishop, A. W. and Henkel, D. J.: The Triaxial Test. Edward Arnold, London

****

2. CGE-202. Soil Dynamics and Machine Foundations

SEMESTER: 2ND	**L**	**T**	**P**	**C**
COURSE NO. CGE - 202	**2**	**1**	**0**	**3**

1. **Subject Area** : **Civil Engineering**
2. **Subject Title** : **Soil Dynamics and Machine Foundations**
3. Subject Code : CGE-202
4. Contact Hours : L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]
5. Credits : 3
6. Semester/Session : 2ND Sem. (Spring Session)
7. Examination Duration (Hrs) : Mid-Term Exam = 1.25; End-Term Exam = 2.5
8. Evaluation Weightage (Marks) : C. P. = 24; End-Term = 26 & End-Term = 50
   [C. P. = Class performance, which includes attendance, assignments and interaction in the class]
9. Pre-requisite : **Geotechnical Engineering**
10. Objectives:
11. Details of Course-as in tabular form below:

Sr. No.	Topic/contents	Contact hours
1	**Introduction to soil dynamics:** Importance of soil dynamics; nature and types of dynamic loading; difference between soil mechanics and soil dynamics; engineering problems involving dynamic loading; seismic force for pseudo-static analysis; equivalent dynamic load to an actual earthquake load.	02
2	**Theory of vibration:** Harmonic motion, free and forced vibrations of single-degree of freedom systems (damped and undamped); vibrations of multi-degree of freedom systems; vibration isolation and screening; vibration measuring instruments.	06
3	**Wave propagation in elastic, homogeneous, and isotropic medium:** Wave propagation; longitudinal and torsional wave propagation in an elastic rod of finite and infinite length; wave propagation in an elastic, homogeneous, and	06

	isotropic infinite medium; wave propagation in an elastic half-space.	
4	**Dynamic soil properties:** Stresses in soil element; concept of soil stiffness, damping ratio and plasticity properties of soil; techniques for estimation of dynamic soil properties from field - invasive and non-invasive testing – (seismic reflection, refraction etc.) and laboratory testing (resonant column test, cyclic triaxial test, torsional shear test, block vibration test etc.).	08
5	**Dynamic bearing capacity of shallow foundations:** pseudo-static analysis (bearing capacity, settlement, tilt, horizontal displacement); dynamic analysis; seismic bearing capacity and seismic settlement.	08
5	**Design of machine foundations:** Types of machine foundation; general design requirements of machine foundations, design guidelines as per codes. **Design of foundation for reciprocating machines:** modes of vibration of a rigid foundation block, linear elastic weightless spring method, elastic half-space method, effect of footing shape on vibratory response, dynamic response of embedded block foundations; soil mass participating in vibrations. **Design of foundation for impact-type machines:** single-degree, two-degree, and three-degree freedom hammer foundations. **Introduction to foundations of rotary machines:** special considerations; design criteria.	12
	Total Contact Hours	**42**

Textbooks:

1. Shamsher Prakash "Soil Dynamics", McGraw Hill Book Company (1981).
2. Steven L. Kramer, "Geotechnical Earthquake Engineering", Prentice Hall Inc (2003).
3. Swami Saran, "Soil Dynamics and Machine Foundations", Galgotia Publications (1999)

References:

1. Robert W. Day, "Geotechnical Earthquake Engineering Handbook", McGraw Hill, New York. (2002)
2. Kenji Ishihara, "Soil Behaviour in Earthquake Geotechnics", Oxford University Press, USA. (1996).
3. G.V. Ramanna and B.M. Das "Principles of Soil Dynamics" CENGAGE Learning, USA. (2011).
4. Richart, F.E., Woods, R.D. and Hall, J.R. Vibrations of soils and foundations. Prentice-Hall, 1970.

****

3. CGE- 203. Applied Soil Mechanics

	L	T	P	C
SEMESTER: 2ND				
COURSE NO. CGE - 203	**2**	**1**	**0**	**3**

1. Subject Area : Civil Engineering
2. Subject Title : Applied Soil Mechanics
3. Subject Code : CGE-203
4. Contact Hours : L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]
5. Credits : 3
6. Semester : 2ND Sem. (Spring Session)
7. Examination Duration (Hrs) : Mid-Term Exam = 1.25; End-Term Exam = 2.5
8. Evaluation Weightage (Marks) : C. P. = 24; End-Term = 26 & End-Term = 50

[C. P. = Class performance, which includes attendance, assignments and interaction in the class]

9. Pre-requisite : **Geotechnical Engineering**

10. Objectives:

11. Details of Course-as in tabular form below:

Sr. No.	Topic/contents	Contact hours
1	**Introduction to Lateral Earth Pressure and Earth Pressure Theories**: Lateral earth pressure coefficients; Passive earth pressure with curved rupture surfaces, Plastic equilibrium in soils, Applications of Earth Pressure Theories, Factors affecting Earth Pressure	06
2	**Design of Flexible Retaining Structures:** **Flexible Retaining Structures:** Sheet Pile Walls, Diaphragm Walls, Mechanically Stabilized Earth (MSE) Walls, Anchored Walls, Soldier Pile and Lagging Walls, Reinforced Soil Slopes **Methods of Design of Flexible Retaining Structures and stability checks:** • **Geotechnical Design-** Earth Pressure Theories, Stability Checks, Embedment Depth (for Sheet Piles), Anchor Design • **Structural Design**-Bending Moments and Shear Forces, Section Design, Connection Detailing, Drainage • **Design Tools and Approaches**-Limit Equilibrium Methods (LEM), Finite Element Method (FEM), Design Standards	12
3	**Design of Rigid Retaining Structures and stability checks**: **Rigid Structures:** Gravity Retaining Walls, Semi-Gravity Walls, Cantilever Retaining Walls, Counterfort Retaining Walls, Buttressed Walls **Methods of Design of Rigid Retaining Structures:** • **Geotechnical Design (Stability Checks):** Check for Sliding**,** Check for Overturning**,** Check for Bearing Capacity**,** Check for Global Stability**.** • **Structural Design: Bending and Shear Design, Design** of Toe and Heel Slab**, Reinforcement** Detailing • **Drainage Considerations:** Weep holes**,** drainage pipes**, or** backfill with granular materials • **Design Methods and Tools:** Rankine's Theory or Coulomb's Theory for earth pressure estimation, Limit Equilibrium Methods for stability**,** Finite Element Analysis (FEA) for more complex structural assessments • **Design Codes:** AASHTO, Eurocode 7 (for geotechnical design), IS: 14458, IS: 456 (India), BS 8002 (UK), ASTM C1372, ASTM A1115/A1115M (US), AS 4678-2002 (Aus)	12
4	**Earth work construction:** • Earth dams and embankments, Choice of material, design of section, filters and drains • Theory of arching in soils and its applications in tunnels and silos, Cavity expansion theory and its applications • Slope stability, Methods of analysis, Slope protection and stabilization	08
5	**Non-conventional retaining systems:** Reinforced retaining walls, Design of open cuts and landfill systems	04
	Total Contact Hours	**42**

References:

1. C. R. I. Clayton, J. Milititsky and R. I. Woods, Earth Pressure and Earth Retaining Structures, Blackie Academic & Professional, 1993.
2. N. P. Kurian, Design of Foundation Systems – Principles and Practices, New Delhi, Narosa publishing House, 2nd Edn., 1994.
3. Budhu, M. (2008). Foundations and Earth Retaining Structures. John Wiley & Sons Incorporated.
4. W. C. Teng, Foundation Design, Prentice-Hall of India Pvt. Ltd.., 1965.
5. J. W. Bowles, Analysis and Design of Foundations, McGraw-Hill, 4th Ed., 1988.
6. Duncan, J. M., Wright, S. G., & Brandon, T. L. (2014). Soil Strength and Slope Stability. John Wiley & Sons.
5. Abramson, L. W., Lee, T. S., Sharma, S., & Boyce, G. M. (2001). Slope Stability and Stabilization Methods. John Wiley & Sons..
8. Ou, C. Y. (2014). Deep Excavation: Theory and Practice. CRC Press.

****

4. CGE- 204. Soil Dynamics Laboratory

	L	T	P	C
SEMESTER: 2ND	**L**	**T**	**P**	**C**
COURSE NO. CGE - 204	**0**	**0**	**2**	**1**

Dynamic testing of soil includes: Undrained Triaxial Test, Cyclic Triaxial Test, Bender Element Test, Multichannel Analysis of Surface Waves Testing, Microtremor (HVSR) method, Ground Penetration Radar, Electrical Resistivity Test etc.

****

5. CGE -205: Seminar

	L	T	P	C
SEMESTER: 2ND	**L**	**T**	**P**	**C**
COURSE NO. CGE - 205	**0**	**0**	**2**	**1**

****

B. ELECTIVE COURSES: ELECTIVE- E3

1. CGE-211. Geotechnical Aspects of Pavement Design, Construction and Performance

	L	T	P	C
SEMESTER: 2ND	**L**	**T**	**P**	**C**
COURSE NO. CGE – 211	**2**	**1**	**0**	**3**

1. Subject Area : **Civil Engineering**

2. Subject Title : **Geotechnical Aspects of Pavement Design, Construction and Performance**

3. Subject Code : CGE-211

4. Contact Hours : L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]

5. Credits : 3

6. Semester : 2ND Sem. (Spring Session)

7. Examination Duration (Hrs) : Mid-Term Exam = 1.25; End-Term Exam = 2.5

8. Evaluation Weightage (Marks) : C. P. = 24; End-Term = 26 & End-Term = 50
[C. P. = Class performance, which includes attendance, assignments and interaction in the class]

9. Pre-requisite : **Geotechnical Engineering**

10. Objectives: To provide a thorough understanding of the geotechnical aspects and to address the geotechnical issues in pavement design, construction and performance for new construction, reconstruction, and rehabilitation projects. Transportation projects, like roads and railways, rely on stable foundations and embankments. Transportation Geotechnics helps engineers understand the properties of the underlying ground (soils and rocks) to design structures that can withstand traffic loads and environmental conditions, preventing failures and ensuring long-term durability.

11. Details of Course-as in tabular form below:

Sr. No.	Topic/contents	Contact hours
1	**Introduction**: • Soil Mechanics for Pavement Engineers, Historical Perspective of Pavement Design, Typical Pavement Types and Components of a Pavement System, Composite Pavements, Unpaved Roads, Performance with Ties to Geotechnical Issues, Case Histories of Pavement Geotechnics. • **Pavement Traffic Loading:** Introduction, Traffic-Monitoring Technology, Summarizing Traffic Data for Pavement Design Input, Wheel Loads, and Design Factors, Load Limits and Enforcement	04
2	**Geotechnical issues in Pavement Design and Performance**: • Foundation characteristics of the subgrade, Key geotechnical issues in pavement design, Environmental Effects, Sensitivity of Pavement Design to Geotechnical Factors.	04

	Incorporation of Geotechnical Factors in Pavement Design: • Stresses in Flexible and Rigid Pavements, Layered System Concepts, Boussinesq Theory. Two Layer Theory - Burmister's Theory. Three Layer System, Pavement Design Methodologies, empirical design approach, mechanistic design approach, Mechanistic-Empirical Design Approach, The AASHTO Design Guide for Flexible and Rigid pavements, Pavement structural design for low-volume roads, Sensitivity to Geotechnical Inputs.	
3	**Geotechnical Exploration, Testing, and Subgrade Characterization-Relevance to Pavement Design:** • Levels of Geotechnical Exploration for Different Types of Pavement Projects: New construction, Reconstruction, and Rehabilitation • Reconnaissance surveys: Preliminary information on general soil conditions, groundwater levels, topography, vegetation, and site accessibility, Soil maps, Aerial photography • Field Exploration or In situ Testing: Soil borings, number and location of borings, Soil sample collection (UDS/DS), Ggeophysical testing, Penetration tests, Observations of the groundwater level. • Geotechnical Testing: Physical, index and engineering properties of sub-grade soils, Soil classification (AASHTO, USCSS, ISCS) • California bearing ratio (CBR) test: CBR of Laboratory-Compacted Soils (ASTM D1883), CBR based on Resistance value (ASTM D2844), CBR based on the soil plasticity (PI) and soil grading. • Resilient Modulus (MR), Resilient Modulus of Soils and Aggregate Materials, Resilient Modulus for Flexible Pavement Design, In Situ Test Methods to Estimate Resilient Modulus	06
4	**Characterization of Pavement Subgrades and Bases:** • **Introduction**: Mechanical Behavior, Resilient Response, Plastic Response, Other Aggregate Layer Indices, Aggregate and Soil Stabilization • **Aggregates:** Introduction, Aggregate Types and Classifications, Aggregate Properties • **Asphalt Materials:** Introduction, Chemical Composition of Asphalt Binders, Preliminaries on Rheology and Viscoelasticity, Asphalt Binder Properties, Asphalt Grades, Binder Modification, Asphalt Mixture Volumetric Analysis, Asphalt Mixture Properties • **Concrete Materials:** Introduction, Cementitious Materials, Hydration, Chemical Admixtures, Properties of Cement, Paste and Mortar, Properties of Concrete	04
5	**Geotechnical Input in Pavement Design** • **Required Geotechnical Inputs:** 1993 AASHTO Design Guide, NCHRP 1-37A Design Guide, Other Geotechnical Properties • **Physical Properties:** Weight-Volume Relationships, Physical, Index and Engineering (Compaction parameters) Properties, , Other Aggregate Tests • **Mechanical Properties:** California Bearing Ratio (CBR), Stabilometer (R-Value), Elastic (Resilient) Modulus, Plate-loading Tests, Triaxial Compression Test, Poisson's Ratio, Structural Layer Coefficients, Modulus of Subgrade Reaction, Interface Friction, Permanent Deformation Characteristics, Coefficient of Lateral Pressure, Soil water characteristics curve (SWCC) parameters for unsaturated soils, Tests for Bituminous Mixtures • **Thermo-Hydraulic Properties:** 1993 AASHTO Guide, NCHRP 1-37A Design Guide	06

	• **Environment/Climate Inputs:** 1993 AASHTO Guide, NCHRP 1-37A Design Guide	
6	**Design of Pavements** • **Design of Flexible Airport Pavements:** Corps of Engineers (CBR) Method, The Federal Aviation Administration (FAA) Method, Canadian Department of Transportation (CDOT) Method, The Asphalt Institute Method **Design of Flexible Highway Pavements:** California Bearing Ratio(CBR) method, Group-Index method, Mc leod method, Burmister Method, IRC Method of Flexible Pavement Design as per IRC 37 –2001, AASHTO Method of Flexible Pavement, Multilayer Elastic Analysis, Minimum Surface Requirements, Differences between Airport and Highway Design Concepts and Design Methods • **Design of Rigid Airport Pavements:** Corps of Engineers Method, Federal Aviation Administration Method, Portland Cement Association Method, Determination of the Modulus of Subgrade Reaction, Modulus of Rupture, Design Charts, Factors of Safety, Base Courses, Compaction Requirements, Design of Steel Reinforcement, Continuously Reinforced Concrete, Junction of Flexible and Rigid Pavements • **Design of Rigid Highway Pavements:** AASHTO Method, IRC recommendations for Rigid pavements as per IRC 58, Calibrated Mechanistic Design Procedure, Portland Cement Association Method, Continuous Reinforced Concrete Pavements, Design of Rigid Pavement Shoulders	12
7	**Pavement Evaluation and Réhabilitation:** • **Pavement Distress** - Flexible Pavements, Rigid Pavements, Pavement • **Performance Monitoring:** Management Systems, geophysical testing, Falling Weight Deflectometer, Drainage Inspection, Instrumented Geosynthetics, Geotechnical related post-construction problems in flexible pavements, Geotechnical related post-construction problems in rigid pavements	04
8	**Construction Specifications, Quality Control, and Quality Assurance** • Construction Specifications • Quality Control and Quality Assurance • Subgrade Compaction and Testing • Field Verification of Design Inputs	02
	Total Contact Hours	**42**

Suggested Books and References:

1. E. J. Yoder and M. W. Witezak (2018): Principles of Pavement Design (PB), Wiley India Exclusive (CBS); Second Edition (26 April 2011)
2. Barry R. Christopher, Charles Schwartz, and Richard Boudreau (2006). Geotechnical Aspects of Pavements, Publication No. FHWA NHI-05-037, National Highway Institute Federal Highway Administration U.S. Department of Transportation Washington, D.C.
3. Nishantha Bandara and Manjriker Gunaratne (2018). Geotechnical Aspects of Pavement Engineering. Momentum Press®, LLC 222 East 46th Street, New York, NY, USA
4. Yang H Haung (2008). Pavement Analysis and Design. Pearson India Education Services Pvt Ltd.
5. Ralps Hass and Hudson, W.R. (1978). Pavement Management System". Mc-Graw Hill Book Company.
6. Das A. (2015). Analysis of Pavement Structures, CRC Press, Taylor and Francis Group, Florida, USA
7. IRC: 37, Guidelines for the Design of Flexible Pavements (Second Revision).

8. IRC: 58, Guidelines for the Design of Plain Jointed Rigid Pavements for Highways (Second Revision).
9. P.G. Lavin (2007). Asphalt Pavements, Taylor and Francis, 1st Ed.
10. Relevant IRC, ASTM, AASHTO and other Codes, Manuals and Specifications
11. MEPDG-1(2008). Mechanistic-Empirical Pavement Design Guide - A Manual of Practice, Interim Edition, American Association of State Highway and Transportation Officials, Washington, D.C., USA.
****

2. CGE- 212. Advanced Topics and case Studies in Geotechnical Engineering

	L	T	P	C
SEMESTER: 2ND	**L**	**T**	**P**	**C**
COURSE NO. CGE – 212	**2**	**1**	**0**	**3**

1. Subject Area : **Civil Engineering**
2. Subject Title : **Advanced Topics and Case Studies in Geotechnical Engineering**
3. Subject Code : CGE-212
4. Contact Hours : L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]
5. Credits : 3
6. Semester : 2ND Sem. (Spring Session)
7. Examination Duration (Hrs) : Mid-Term Exam = 1.25; End-Term Exam = 2.5
8. Evaluation Weightage (Marks) : C. P. = 24; End-Term = 26 & End-Term = 50
[C. P. = Class performance, which includes attendance, assignments and interaction in the class]
9. Pre-requisite : **Geotechnical Engineering**
10. Course objectives-This course will enable students to:
- Understanding the failure mechanism in geotechnical engineering
- Evaluating the soil as different construction materials and its behaviour
- Role of soil in past and future in construction industry

11. Details of Course-as in tabular form below:

Sr. No.	Topic/contents	Contact hours
1	**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.	08
2	**Module -2** Behaviour of different soils under different foundations and different environmental conditions. Calculated risk and safety factors in applied soil engineering	08
3	**Module -3** Concepts and application of Forensic Geotechnical Engineering	08
4	**Module -4** New concepts in consolidation settlements, settlements and bearing capacity	08

5	**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.,	10
	Total Contact Hours	**42**

Suggested Books:

1. Fundamentals of soil behaviour – Mitchel J. K. (2012)- McGraw- Hill Co.
2. Soil Mechanics SI version- Lambe T. W. and Whitman R. V. (2011) John Wiley & Sons
3. Soil Mechanics and Foundations, Muniram Budhu (2011), John Wiley & Sons, Inc.
4. Soil Mechanics, J. E. Bowles (2012), 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(2012), Spon Press Taylor & Francis

****

3. CSE- 201. Finite Element Analysis

SEMESTER: 2ND	L	T	P	C	(Str. Engg Faculty)
COURSE NO. CSE – 201	**2**	**1**	**0**	**3**	

1. Subject Area : **Civil Engineering**
2. Subject Title : **Finite Element Analysis**
3. Subject Code : CSE-201
4. Contact Hours : L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]
5. Credits : 3
6. Semester : 2ND Sem. (Spring Session)
7. Examination Duration (Hrs) : Mid-Term Exam = 1.25; End-Term Exam = 2.5
8. Evaluation Weightage (Marks) : C. P. = 24; End-Term = 26 & End-Term = 50
[C. P. = Class performance, which includes attendance, assignments and interaction in the class]
9. Pre-requisite : **NILL**
10. Objectives:
11. Details of Course-as in tabular form below:

Sr. No.	Topic/contents	Contact hours
1	Introduction to Finite Element Method. Brief History of the Development. Advantages & Disadvantages of Finite Element Method. Finite Element Method-The Displacement Approach.	6

2	Foundations of the FEM- Energy Principles.	6
3	One Dimensional Finite Elements. Stiffness Matrix for the basic Bar & Beam Element Representation of Distributed Loading. The Assembly Process within the PMPE Approach. Element Stresses.	8
4	Shape Functions & Interpolation Polynomials. Refined One Dimensional Elements.	4
5	Finite Elements for Two Dimensional Planar Bodies. Triangular Elements for Plane Stress or Strain Conditions. Higher Order Triangular Elements. Rectangular Elements for Plane Stress or Strain Conditions. Higher Order Rectangular Elements : Lagrange Element Family.	10
6	Serendipity Rectangles & Hexahedra. The Isoparametric Concept. Properties of Isoparametric Elements. Numerical Integration.	8
	Total Contact Hours	**42**

Books recommended:

1. Matrix & Finite Element Displacement Analysis of Structures: D.J.Dawe.
2. Matrix Finite Element Computer & Structural Analysis: M.Mukhopadhyay.
3. Finite Element Structural Analysis: T.Y.Yang.
4. Concepts & Applications of Finite Element Analysis: Robert D.Cook.

****

ELECTIVE - 4

1. CGE- 221. Environmental Geotechnology

SEMESTER: 2ND	**L**	**T**	**P**	**C**
COURSE NO. CGE – 221	**2**	**1**	**0**	**3**

1. Subject Area : **Civil Engineering**

2. Subject Title : **Environmental Geotechnology**

3. Subject Code : CGE-221

4. Contact Hours : L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]

5. Credits : 3

6. Semester : 2ND Sem. (Spring Session)

7. Examination Duration (Hrs) : Mid-Term Exam = 1.25; End-Term Exam = 2.5

8. Evaluation Weightage (Marks) : C. P. = 24; End-Term = 26 & End-Term = 50
[C. P. = Class performance, which includes attendance, assignments and interaction in the class]

9. Pre-requisite : **NILL**

10. Objectives:

11. Details of Course-as in tabular form below:

Sr. No.	Topic/contents	Contact hours
1.	Soil as a multiphase system; Soil-environment interaction; Properties of water in relation to the porous media; Water cycle with special reference to soil medium. Soil mineralogy: Significance of mineralogy in determining soil behaviour; Mineralogical characterization.	12
2.	Mechanisms of soil-water interaction: Diffuse double layer models; Force of attraction and repulsion; Soil-water-contaminant interaction; Theories of ion exchange; Influence of organic and inorganic chemical interaction. Introduction to unsaturated soil mechanics: Water retention property and soil-water characteristic curve; flow of water in unsaturated soil.	16
3.	Concepts of waste containment facilities; desirable properties of soil; contaminant transport and retention; contaminated site remediation. Introduction to advanced soil characterization techniques; volumetric water content; gas permeation in soil; electrical and thermal properties; pore-size distribution; contaminant analysis.	14
	Total Contact Hours	**42**

References:

1. Mitchell J. K and Soga K. (2005). Fundamentals of Soil Behavior, John Wiley and Sons Inc.,
2. Fang H-Y (1997). Introduction to Environmental Geotechnology, CRC Press.
3. Sharma H. D. and Reddy K. R. (2004). Geoenvironmental Engineering: Site Remediation, Waste Containment and Emerging Waste Management Technologies. John Wiley & Sons, New Jersey, USA.
4. Qian X., Koerner R.M. and Gray D.H. (2001). Geotechnical Aspects of Landfill Design and Construction. Pearson.
5. Rowe R. K., Quigley R. M., Brachman R. W. I. and Booker J. R. (2004). Barrier Systems for Waste Disposal Facilities., Taylor & Francis, London, UK. 2004.

****

2. CGE- 222. Soil-Structure Interaction (SSI)

	L	T	P	C
SEMESTER: 2ND	**L**	**T**	**P**	**C**
COURSE NO. CGE -222	**2**	**1**	**0**	**3**

1. Subject Area : **Civil Engineering**

2. Subject Title : **Soil-Structure Interaction (SSI)**

3. Subject Code : CGE-214-E4

4. Contact Hours : L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]

5. Credits : 3

6. Semester : 2ND Sem. (Spring Session)

7. Examination Duration (Hrs) : Mid-Term Exam = 1.25; End-Term Exam = 2.5

8. Evaluation Weightage (Marks) : C. P. = 24; End-Term = 26 & End-Term = 50
[C. P. = Class performance, which includes attendance, assignments and interaction in the class]

9. Pre-requisite : **NILL**

10. Objectives: The course focus on the various principles governing soil-structure interaction effect and

different soil-structure interaction models for shallow and pile foundations under various loading conditions and subgrade characteristics.

11. Details of Course-as in tabular form below:

Sr. No.	Topic/contents	Contact hours
1	Introduction to soil-stresses and displacement in soils, Soil-Foundation interaction, Interface behaviour, Different methods of soil-structure Analysis, Kinematic interaction, Inertial interaction, Basic equation of motion, General soil-structure interaction problems- Shallow foundation, Sheet piles, Mat/Raft foundation, etc. Codal provisions of India and others. Stiffness of Surface foundation, Material nonlinearity of soil, Determination of subgrade modulus and parameters influencing subgrade modulus, Different foundation models (one-parameter, two-parameter models, etc.) with linear and non-linear stress-strain characteristics.	8
2	Beams with finite length and various end conditions, semi-infinite beams, Infinite beams subjected to various loading conditions, Continuity among the foundation soil layers beams on two-parameter soil medium (infinite and finite beam), Beams with variable EI and subgrade modulus	12
3	Analysis of finite plate, Axisymmetric loading of a circular plate, Analysis of rigid circular plate, Analysis of rectangular plate, Plate resting on an elastic half-space, Approximate method of Analysis, Deflection of an infinite plate on a Winkler medium.	12
4	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, Load deflection prediction for laterally loaded piles, Non-linear load-deflection response, Subgrade reaction and elastic Analysis, Pile-raft system, Solutions through influence charts.	10
	Total Contact Hours	**42**

References:

5. Bowles, J. E. - Foundation Analysis & Design 5th Edition McGraw-Hill Companies, Inc. 1996.
6. Das, B. M. - Principles of Foundation Engineering 5th Edition Nelson Engineering, 2004
7. Poulos, H. G., and Davis, E. H. - Pile Foundation Analysis and Design, 1980.
8. Rolando P. Orense, Nawawi Chouw & Michael J. Pender - Soil-Foundation-Structure Interaction, CRC Press, Taylor & Francis Group, London, UK., 2010.
9. Scott, R. F. - Foundation Analysis, Prentice Hall, Englewood Cliffs, 1981.
10. Selvadurai, A. P. S. Elastic Analysis of Soil-Foundation Interaction, 1979.
11. Structure Soil Interaction - State of Art Report, Institution of Structural Engineers, 1978.
12. ACI 336. Suggested Analysis and Design Procedures for combined footings and Mats, 1988.
13. Wolf, J.P., Dynamic Soil-Structure Interaction , Prentice-Hall, 1985

****

3. CWE- 223. Applications of AI/ML in Civil Engineering

	L	T	P	C	
SEMESTER: 2ND	**L**	**T**	**P**	**C**	**(WRE Faculty)**
COURSE NO. CWE – 223	**2**	**1**	**0**	**3**	

1. Subject Area : **Civil Engineering**
2. Subject Title : **Applications of AI/ML Tools in Civil Engineering**
3. Subject Code : CWE-223
4. Contact Hours : L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]
5. Credits : 3
6. Semester : 2ND Sem. (Spring Session)
7. Examination Duration (Hrs) : Mid-Term Exam = 1.25; End-Term Exam = 2.5
8. Evaluation Weightage (Marks) : C. P. = 24; End-Term = 26 & End-Term = 50
[C. P. = Class performance, which includes attendance, assignments and interaction in the class]
9. Pre-requisite : **NILL**
10. Objectives: To impart understanding of basic principles of remote sensing, image processing and applications.
11. Details of Course-as in tabular form below:

Sr. No	Contents	Contact Hours
1.	Introduction to AI and Machine learning Review of statistics and linear algebra: Basic definitions; probability, conditional probability, expectation, normalization and standardization; parameter estimation and uncertainty; eigen value; eigen vectors; positive definite matrix, singular value decomposition	8
2	Regression: Simple linear regression, multiple regression, model adequacy tests, Overfitting and regularization; ridge regression, Feature selection, Lasso regression, Nearest neighbor and Kernal regression. Gradient decent for solution of linear regression; Examples and case studies	8
3.	Classification and clustering: Linear and logistic classifiers, support vector machines; Hierarchical clustering.	6
4.	Decision trees: Ensemble learning: gradient boosting, and random forests; nearest neighbor; mixture models, expectation-maximization algorithm.	6
5	Neural networks: Perceptron, multi-layer perceptron, Feedforward network, back propagation; Computation; Coding; training; recurrent neural networks (RNN) and convolution neural networks (CNN); Case studies	10

6	Deep Reinforcement Learning: policy gradients and deep Qnetworks (DQNs), including a discussion of Markov decision processes (MDPs).	4
	Total Contact Hours	**42**

Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1.	Trevor Hastie, Robert Tibshirani, and Jerome Friedman, The Elements Of Statistical Learning: Data Mining, Inference, And Prediction, 2nd Edition, Springer	2019
2.	Gilbert Strang, Linear Algebra and Learning from Data, Wellesley, Cambridge Press,	2019
3.	Aurélien Géron, Hands-on Machine Learning with Scikit-Learn, Keras & TensorFlow, 2nd Edition; O'Reilly Media, Inc.,	2019
4.	Andriy Burkov, The hundred-page machine learning book, True Positive Inc	2025

****

SEMESTER – III: AUTUMN SESSION

A. CORE COURSES (2025 Batch Onwards)

1. CGE -301. Ground Improvement Techniques

	L	T	P	C
SEMESTER: 3RD	**L**	**T**	**P**	**C**
COURSE NO. CGE - 301	**2**	**1**	**0**	**3**

1. Subject Area : **Civil Engineering**

2. Subject Title : **Ground Improvement Techniques**

3. Subject Code : CGE-301

4. Contact Hours : L-T-P: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]

5. Credits : 3

6. Semester : Spring Session

7. Examination Duration (Hrs) : Mid-Term Exam = 1.25; End-Term Exam =2.5

8. Evaluation Weightage (Marks) : C. P. = 24; Mid-Term = 26 & End-Term = 50
[C. P. = Class performance, which includes attendance, assignments and interaction in the class]

9. Pre-requisite : **Geotechnical Engineering**

10. Objective: To impart understanding of Application of Engineering Principles of Ground Modification in the field of Civil Engg.

11. Course Details as in tabular form below:

Sr. No.	Course Contents	Contact Hours
1.	**INTRODUCTION** • Soil Types, Soil Investigation & Classification • Ground Modification/Stabilization • Need for Engineered Ground Improvement • Classification of Ground Improvement Techniques • Suitability, Feasibility and Desirability of Ground Improvement Techniques • Current & Future Developments	12
2.	**GROUND IMPROVEMENT TECHNIQUES** • **Mechanical Modification** Introduction to Mechanical Modification, Principles of Soil Densification, Properties of Compacted Soil, Compaction Control, Specification of Compaction Requirements, Types of Compaction Equipment	12

	• **Chemical Modification/Stabilization** Effect of various admixtures on Engineering Properties of Soils such as: Cement, Lime, Fly ash, Bitumen, Cement-Lime-Fly ash. Other chemical additives such as- NaCL, $CaCL_2$, CaSO4, $Ca(OH)_2$, NaOH etc., Grouting- Applications to Embankments, Foundations & Sensitive Soils, Admixtures in Pavement Design. • **Hydraulic Modification** Objectives & Techniques, Dewatering Systems, Soil-Water Relationships, Single & Multiple-Well Formulas, Drainage of Slopes, Filtration & Seepage Control, Pre-loading & Vertical Drains, Electrokinetic Dewatering & Stabilization	
3.	**GROUND IMPROVEMENT TECHNIQUES (Contd....)** • **Modification by Inclusions, Confinement & Exclusion Techniques** Evolution of Soil Reinforcement, Applications of Geosynthetics Material in Civil Engineering, Granular piles, Soil Nailing, Soil Anchors, Soil Confinement by Formwork, Sheet Piles, Contiguous Bored Piles, Slurry Trenches, Diaphragm Walls, Compressed Air. • **Thermal Modification** Thermal Properties of Soils, Heat Treatment of Soils, Ground Freezing, Strength & Behavior of Frozen Ground. • Case histories	12
4.	• **Introduction to Methods of Microstructural Characterization of Soils:** Microstructural Characterization of Treated and Untreated Soils	06
	Total Contact Hours	**42**

COURSE TEXTBOOK: **Some useful resources are:**

1. Hausmann M. R. (1990). Engineering Principles of Ground Modification", McGraw-Hill Pub. Co. New York.
2. Ingles O. G. and Metcalf J. B. (1972). Soil Stabilization: Principles and Practice, Butterworths, London.
3. Bell F. G. (1975). Methods of Treatment of Unstable Ground, Newnes-Butterworths, London Kasmalkar, B. J. (1997). Geotech. Engineering. Pune Vidyarthi Griha Prakashan-1786, Sadashiv Peth, Pune-411030.
4. Moseley, M. P. (1993). Ground Improvement, Blackie Academic & Professional..J K Mitchell & Kenichi Soga (2005). Fundamentals of Soil Behavior, *John* Wiley & Sons, New York.
5. P. P. Raj (1999). Ground Improvement Techniques, laxmi Publications (P) Ltd. New Delhi.
6. Jones. C. J. E. P. (1996). Earth Reinforcement and Soil Structures, Butterworth's, London.
7. J K Mitchell (1978). Improving soil conditions by surface and subsurface treatment methods-Overview, ASCE Metropolitan Section Foundation And Soil Mechanics Group Seminar, New York, USA.
8. Nelson, J. D. and Miller, D. J. (1992). Expansive Soils, John Wiley and Sons, Inc., New York, 1992.
9. .Koener R. M. (1985). Construction and Geotechnical Methods in Foundation Engineering, McGraw-Hill Pub. Co., New York.

10. Koerner .R. M. (1994). Designing with Geosynthetics, Prentice-Hall Pub.
11. Koerner. R. M. and Welsh. J. P. (1980). Construction and Geotechnical Engineering Using Synthetic Fabrics, Wiley Interscience, New York.
12. Bell. F.G. (1987). Ground Engineer's Reference Book, Butterworth's, London.
13. Patrick Echlin (2009). Handbook of Sample Preparation for Scanning Electron Microscopy and X-Ray Microanalysis. © Springer Science+Business Media, LLC 2009.
14. David Brandon and Wayne D. Kaplan (2008). Microstructural Characterization of Materials. John Willey & Sons

****

2. CGE-302. Frost Geotechnics

	L	T	P	C
SEMESTER: 3RD	**L**	**T**	**P**	**C**
COURSE NO. CGE - 302	**2**	**1**	**0**	**3**

1. Subject Area : **Civil Engineering**

2. Subject Title : **Frost Geotechnics**

3. Subject Code : CGE-302

4. Contact Hours : L-T-P: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]

5. Credits : 3

6. Semester : Spring Session

7. Examination Duration (Hrs) : Mid-Term Exam = 1.25; End-Term Exam = 2.5

8. Evaluation Weightage (Marks) : C. P. = 24; Mid-Term = 26 & End-Term = 50
[C. P. = Class performance, which includes attendance, assignments and interaction in the class]

9. Pre-requisite : **Geotechnical Engineering**

10. Objective: To impart understanding of Application of Frost Geotechnics in the field of Civil Engg.

11. Course Details as in tabular form below:

Unit No.	Course Contents	Contact Hours
Unit -1	**I. Introduction to Frost Geotechnics:** • **Frost Geotechnics**: Definition of Frost Geotechnics and its significance, Understanding frozen ground and its characteristics, Importance of frost geotechnics in cold regions and permafrost areas. • **Soil Freezing Permafrost:** Geo thermal profile, Freezing index, Depth of frost penetration & its determination, Freezing in coarse and fine grained soil, Fields frost heaving. • **Time Capsule on Frost Geotechnics** (TC216) **II. Geotechnical Engineering in Cold Regions:** • **Fundamentals of Cold Regions:** Climate, Temperature, Temperature range, Freezing season, Heat Transfer, Pore water Phase Change, • **Seasonal Frost:** Frost Susceptible Soil, Freeze-Thaw (Frost Action), Building Foundations, Roads • **Permafrost**: Occurrence, Permafrost zone, Properties of Frozen Soil, Design	16

	Approaches, Foundation Types, Frozen Soil Creep. **III. Frost heave in soils: Concepts and engineering:** • Factors influencing frost susceptibility in soils, Methods for determining frost susceptibility. • Mechanism of frost heave and its effects on structures, Frost heave prediction and modeling. • **Freezing Phenomena:** Ice formation, Ice types, Ice strength, Freezing Index, Calculating the rate of ice growth, Loading an ice sheet, Ice forces on structures, Freezing in pipes and closed containers	
Unit – 2	**IV. Permafrost and its Engineering Challenges:** Definition and characteristics of permafrost, Geotechnical properties of permafrost soils, Challenges associated with construction in permafrost regions, and Permafrost thaw and its impact on infrastructure. **V. Properties of Frozen Ground:** • **Physical and Thermal Properties:** Performance of materials in cold Regions, Examining the unique physical and thermal properties of frozen ground, including density, thermal conductivity, specific heat, and freezing point depression. • **Mechanical Properties:** Investigating the strength, stiffness, and deformation characteristics of frozen soils, including their behavior under different loading conditions. • **Freeze-Thaw Cycles and Their Effects:** Understanding how repeated freeze-thaw cycles can alter soil properties and contribute to settlement or deformation	12
Unit - 3	**VI. Design Considerations for Structures in Cold Regions:** • Foundations in frost-affected soils, Design of pavements and roads in cold regions, Slope stability analysis in permafrost, and Drainage systems and frost protection measures. **VII. Remedial Measures for Frost-Related Problems:** • Drainage systems to mitigate frost heave, Soil stabilization techniques for frost-susceptible soils, Insulation and thermal protection measures. • Case studies of frost-related problems and their solutions. **VIII. Other Related Topics:** • Artificial ground freezing, Geotechnical monitoring and instrumentation, and Impact of climate change on frost geotechnics.	14
	Total Contact Hours	**42**

Suggested Books:

1. Introduction To Frozen Ground Engineering (1994) by Orlando B. Andersland and Branko Ladanyi, Springer-Science+Business Media, B.V.
2. Cold Regions Pavement Engineering (2009) by Guy Doré and Hannele K. Zubeck, ASCE Press Newyork, USA
3. Bases and Foundations on Frozen Soil (1960) by Highway Research Board Special Report 58, Washington, D. C., USA
4. Introduction to Cold Regions Engineering (1997) by Dean R. Freitag Terry McFadden, ASCE Press 345 East 47th Street New York, New York 10017-2398

****

3. CGE-303. Dissertation Stage-I

SEMESTER: 3RD	L	T	P	C
COURSE CODE: CGE - 303	0	0	12	6

****

B. ELECTIVE COURSES: ELECTIVE-5

1. CGE -311. LANDFILL ENGINEERING

SEMESTER: 3RD	L	T	P	C
COURSE NO. CGE – 311	2	1	0	3

1. Subject Area : **Civil Engineering**
2. Subject Title : **Landfill Engineering**
3. Subject Code : CGE-311
4. Contact Hours : L-T-P: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]
5. Credits : 3
6. Semester : Spring Session
7. Examination Duration (Hrs) : Mid-Term Exam = 1.25; End-Term Exam = 2.5
8. Evaluation Weightage (Marks) : C. P. = 24; Mid-Term = 26 & End-Term = 50
[C. P. = Class performance, which includes attendance, assignments and interaction in the class]
9. Pre-requisite : **Geotechnical Engineering**
10. Objective:
11. Course Details as in tabular form below:

Sr. No.	Course Contents	Contact Hours
PART-I	**EVOLUTION OF SOLID WASTE** • Solid Waste-Sources and Types • Properties of Solid waste • Waste Handling and Separation, Storage & Processing at Source • Disposal & Residual Matter • Planning, Sitting & Permitting of Waste management Facilities	12
PART-II	**LANDFILL ENGINEERING** • **Introduction** Need for Landfills, Types of Landfills, Physical Characteristics of Landfills. • **Barrier Systems**	

	Concept of Barrier Systems & Engineering Design, Transport Mechanism, Filter Criteria • **Appraisal of EPA Regulations, Property characterization of Landfill Components.** • **Landfill Liners** Types of Landfill Liners, Engineering Properties, Analysis, design & Construction of Liners, Leachete Collection Pipes. • **Landfill Covers** Basic Concepts for Cover Systems, Components, Assessment, Advantages & Disadvantages, Protection Layer, Barrier Layer. • **Landfills & Impoundments** Objectives of Waste Disposal Facilities, Siting of Landfills, Containment Technology, Disposal Unit & Operations. • **Water Balance for Landfills** • **Stability of Landfills** • **Evaluation of Landfill Performance** Evaluation of Landfill Performance Using HELP Software & Economic evaluation & Risk Assessment of Landfills,, Role of GIS, Construction Details & Performance Monitoring.	24
	Total		36

Recommended Books:

- Geotechnics of Landfills :GermanTechnical Regulations.
- Integrated Solid Waste Management: Engg. Principles & Management Issues : Tchobanoglous, George, Hilary Theisen & samuel Vigil.
- Geotechnical Practice for Waste Disposal : David E. Daniel
- Soil Stabilization : Ingles, O. G. & Metcalf, J. B.

****

2. CGE – 312. Geotechnical Earthquake Engineering

	L	T	P	C
SEMESTER: 3RD	**L**	**T**	**P**	**C**
COURSE NO. CGE – 312	**2**	**1**	**0**	**3**

1. Subject Area **: Civil Engineering**
2. Subject Title **: Geotechnical Earthquake Engineering**
3. Subject Code : CGE-312
4. Contact Hours : L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]
5. Credits : 3

6. Semester/Session : 3RD Sem. (Autumn Session)

7. Examination Duration (Hrs) : Mid-Term Exam = 1.25; End-Term Exam = 2.5

8. Evaluation Weightage (Marks) : C. P. = 24; End-Term = 26 & End-Term = 50

[C. P. = Class performance, which includes attendance, assignments and interaction in the class]

9. Pre-requisite : **Geotechnical Engineering**

10. Objectives:

11. Prerequisites: Geotechnical Engineering-I and II; Soil Dynamics; probability and statistics.

12. Details of Course-as in tabular form below:

Sr. No.	Course Contents	Contact Hours
1.	**Introduction:** Scope and objective; nature and types of earthquake loading; importance of geotechnical earthquake engineering; seismic hazards and types; word seismicity; significant historical earthquakes, IS1893 seismic zonation map. **Seismology:** Internal structure of earth; continental drift and plate tectonics; faults; elastic rebound theory; location of earthquakes (focus, epicentre); size of earthquakes (magnitude, intensity); magnitude scales (Richter/Local, surface and body-wave magnitudes); seismic moment and moment magnitude.	06
2.	**Strong ground motion:** Introduction; strong-motion measurement (seismographs and accelerographs); strong-motion instrument arrays; strong-motion records and processing; ground motion parameters (amplitude, frequency content, duration, and other measures); fourier amplitude spectra; arias intensity; power spectral density; response spectra; estimation of ground motion parameters; spatial variability of ground motion; attenuation relationships.	06
3.	**Seismic hazard analysis:** identification of seismic sources; attenuation laws; magnitude-recurrence relationships (Gutenberg–Richter recurrence law, bounded Gutenberg–Richter recurrence law, characteristic earthquake recurrence law); deterministic seismic hazard analysis; probabilistic seismic hazard analysis (earthquake source characterisation; spatial uncertainty, temporal uncertainty, probability computations); seismic zonation maps; microzonation procedure.	06
4.	**Stress-strain behaviour of cyclically loaded soils:** equivalent linear model, cyclic non-linear models; strength of cyclically loaded soils (definition of failure, cyclic strength, monotonic strength).	10
5.	**Ground response analysis:** introduction; one-dimensional ground response analysis; linear, equivalent-linear, and non-linear analyses. **Local site effects and design ground motions:** effect of local site effects on ground motion; design earthquakes and spectra; development of design parameters (site-specific and code-based); development of ground motion time histories.	06
6.	**Liquefaction:** liquefaction susceptibility; initiation of liquefaction; effects of liquefaction; liquefaction-related phenomena; liquefaction potential; evaluation of liquefaction hazards. **Seismic slope stability and design of retaining walls:** earthquake induced landslides; seismic slope stability analysis; seismic design considerations for	08

	retaining walls. **Soil improvement for remediation of seismic hazards:** densifications; reinforcement; grouting and mixing; drainage; verification of soil improvement through lab and field tests.	
	Total Contact Hours	**42**

Textbooks:

1. Roberto Villaverde "Fundamental Concepts of Earthquake Engineering", CRC Press, Taylor and Francis (2009).
2. Steven L. Kramer, "Geotechnical Earthquake Engineering", Prentice Hall Inc (2003).
3. Brendon Bradley, Jack Baker, Peter Stafford. "Seismic Hazard and Risk Analysis" Cambridge University Press (2021).

References:

1. Robert W. Day, "Geotechnical Earthquake Engineering Handbook", McGraw Hill, New York. (2002)
2. Kenji Ishihara, "Soil Behaviour in Earthquake Geotechnics", Oxford University Press, USA. (1996).

****

3. CGE-313. Risk and Reliability Analysis in Geotechnical Engineering

	L	T	P	C
SEMESTER: 3RD	**L**	**T**	**P**	**C**
COURSE NO. CGE – 313	**2**	**1**	**0**	**3**

1. Subject Area : **Civil Engineering**

2. Subject Title : **Reliability and Risk Analysis in Geotechnical Engineering**

3. Subject Code : CGE-313

4. Contact Hours : L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]

5. Credits : 3

6. Semester/Session : 3RD Sem. (Autumn Session)

7. Examination Duration (Hrs) : Mid-Term Exam = 1.25; End-Term Exam = 2.5

8. Evaluation Weightage (Marks) C. P. = 24; End-Term = 26 & End-Term = 50
[C. P. = Class performance, which includes attendance, assignments and interaction in the class]

9. Pre-requisite **Geotechnical Engineering**

10. Objectives:

11. Details of Course-as in tabular form below:

Unit No.	Course Contents	Contact Hours
Unit -1	Introduction: Sources and types of uncertainties associated with geotechnical analysis, importance of probabilistic methods and reliability-based analysis in geotechnical engineering. Review of probability and statistics: Discrete and continuous random variables, parameter estimation, testing of hypothesis, regression analysis	12
Unit - 2	Fundamentals of reliability analysis: First Order Second Moment (FOSM) method, First Order Reliability Method (FORM), Second Order Reliability	12

	Method (SORM), Monte Carlo Risk Analysis	
Unit - 3	Application towards geotechnical problems: Characterization of uncertainty in field-measured and laboratory-measured soil properties, uncertainty in interpretation techniques. Spatial variability of soil properties, scale of fluctuations, estimation of auto correlation and auto covariance Probabilistic groundwater modeling, flow through earth dams Probabilistic slope stability analysis Fundamentals of LRFD design methodology, reliability based design of shallow and deep foundations, settlement analysis Reliability based liquefaction analysis, lateral spreading Development of fragility curves for geotechnical problems	18
	Total Contact Hours	**42**

Textbooks:

1. Phoon, K. K., & Ching, J. (Eds.). (2018). *Risk and reliability in geotechnical engineering*. CRC Press.
2. Lacasse, S., & Nadim, F. (1998). Risk and reliability in geotechnical engineering.
3. Fenton, G. A., & Griffiths, D. V. (2008). *Risk assessment in geotechnical engineering* (Vol. 461). New York: John Wiley & Sons.

****

4. CSE-303. Design of Bridge Substructures

	L	T	P	C	
SEMESTER: 3RD	**L**	**T**	**P**	**C**	**(Str. Engg Faculty)**
COURSE NO. CSE – 303	**2**	**1**	**0**	**3**	

1. Subject Area : **Civil Engineering**

2. Subject Title : **Design of Bridge Substructures**

3. Subject Code : CSE-303

4. Contact Hours : L-T-P:: 2-1-0 [L: Lecture, T: Tutorial & P: Practical]

5. Credits : 3

6. Semester/Session : 3RD Sem. (Autumn Session)

7. Examination Duration (Hrs) : Mid-Term Exam = 1.25; End-Term Exam = 2.5

8. Evaluation Weightage (Marks) : C. P. = 24; End-Term = 26 & End-Term = 50
[C. P. = Class performance, which includes attendance, assignments and interaction in the class]

9. Pre-requisite : **Analysis and Design of Foundation Systems**

10. Objectives:

11. Details of Course-as in tabular form below:

Unit No.	Course Contents	Contact Hours
1	• Distribution of Horizontal Forces among Bridge Supports in Straight, Curved, and Skewed Decks	05
2	• Analysis and design of piers and pier caps	07
3	• Analysis and design of abutments	06

4	• Analysis and design of Pile foundations	10
5	• Analysis and design of well foundations.	10
6	• Different Types of Bearings and Design of Elastomeric Bearings	03
7	• Seismic restrainers	01
	Total Contact Hours	**42**

Text Books:

1. Vijay Singh, **Wells and Caissons**, Nem Chand & Bros.
2. Swami Saran, **Analysis and Design of Substructures**, Oxford & IBH Publishing Co Pvt Ltd.
3. Johnson Victor, D. **Essentials of Bridge Engineering**, Oxford & IBH Publishing Co. Pvt. Ltd.
4. Krishna Raju, N. **Design of Bridges**, Oxford & IBH Publishing Co. Pvt. Ltd.

References:

1. Rajgopal, N. **Bridge Superstructure**, Narosa Publishing House.
2. Fryba, L. **Dynamics of Railway Bridges**, Thomas Telford.
3. Raina, V. K. **Concrete Bridge Practice: Analysis, Design and Economics**, Tata McGraw Hill.
4. Aswani, M. G., Vazirani, V. N., and Ratwani, M. M. **Design of Concrete Bridges**, Khanna Publishers.
5. Ponnuswamy, S. **Bridge Engineering**, Tata McGraw-Hill.
6. Jagadish, T. R., and Jairam, M. A. **Design of Bridge Structures**, Prentice Hall of India.
7. Phatak, D. R. **Bridge Engineering**, Satya Prakashan.
8. Bakht, B., and Jaegar, L. G. **Bridge Analysis Simplified**, McGraw-Hill.

****

SEMESTER – IV: SPRING SESSION

Sr. No.	Subjects	L	T	P	Credit
CGE-401	Dissertation Stage-II	-	-	24	12
	Total Credits				**12**

Grand Total of Credits = 60

****

EVALUATION:

Attendance & Class performance	: 24%
Mid-Term Exam	: 26%
End-Term Exam	: 50%

NOTE:

7. Each Elective Group contains at least one subject of inter-department or of other P.G. areas of the department in order to make the system more flexible and to meet the options of P.G. students of their interest area.
8. Examination of Practicals/Tutorials will be conducted by two internal examiners.
9. One external examiner & concerned internal examiners shall be conducting viva-voce examination in case of Dissertation at Semester IV.
10. Evaluation and examination system for seminar and dissertation will be at par with other P.G. programs of the department.
11. The dissertation involves a detailed study of a Transportation related, problem (actual field/ research) which a student has to carry out under the supervision of one of the faculty members of the Department. The dissertation work can also be of interdisciplinary nature with transportation element involved.
12. Part-time students will be eligible to take up the 3rd semester regular in their 5th semester, only when they have successfully completed the 1st and 2nd semesters.

Existing Faculty Position

7. Prof. B. A. Mir, Professor, M.E. (Geotechnical Engineering) IISc Bangalore, Ph. D. IIT Bombay
8. Prof. M. Y. Shah, Professor, M. Tech. (Geotechnical Engineering) IIT Delhi, Ph.D. IIT Roorkee
9. Dr. Majid Hussain, Assistant Professor, B. Tech. NIT Srinagar, Ph.D. (Geotechnical Engineering) IIT Gandhinagar
10. Dr. Rajesh P. Shukla, Assistant Professor, M. Tech. (Geotechnical Engineering) IIT Kanpur, Ph.D. IIT Roorkee
11. Dr. Ritesh S. Ingale, Assistant Professor, M. Tech. (Geotechnical Engineering) S.V. NIT Surat, Ph.D. V. NIT Nagpur
12. Dr. Falak Zahoor, Assistant Professor, B. Tech NIT Srinagar, Ph.D. (Geotechnical Engineering) IIT Delhi

****