Semester- I

NUMERICAL METHODS AND OPTIMIZATION TECHNIQUES			
Course Code	MCV101	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

- To formulate Linear programming for obtaining solution for real world problems
- To learn Non-linear, geometric and dynamic programming techniques for civil engineering problems.
- To analyze the civil engineering data and characterize with regression equations and test its efficacy.
- To understand the techniques of numerical methods for solving differential equations and their applications.
- To understand project management technique for use in real civil engineering projects.

Module-1

Introduction to optimization techniques, nature and characteristics of operation research; Introduction to Linear programming, graphical solution, solution by simplex and revised simplex technique.

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Solving numerical, Assignments

Module-2

Non-Linear Programming- one dimensional minimization methods, elimination methods, Fibonacci method; Dynamic programming- Introduction, Approaches, Application and case studies;Geometric programming methods- Introduction, Approaches, conversion of NLP as a sequence of LP.

Teaching-Learning Process	Black-Board Teaching, Solving numerical, Group work and Assignments

Module-3

Statistical inferences- Methods of least square and regression, multiple regression.Concept of probability, Random Variables, Binomial, Poisson and Normal distribution –applications, Chi- squared testand Analysis of Variance.

Teaching-Learning Process	Black-Board Teaching, Solving numerical, Group work and Assignments

Module-4

Numerical Solutions: Solution of Ordinary differential equations: Euler's method, and RangaKutta 3rd and 4th order method, Taylor's series methodSolutions for Integral Equations: Trapezoidal rule, Simpson's 1/3rd and 3/8th rule, and Weddle's Rule.

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Solving numerical, Assignments

Module-5

Introduction to Project Management, Network analysis- CPM & PERT

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Solving numerical, Flipped classroom, Assignments

PRACTICAL COMPONENT OF IPCC (using any computer software app/tool)

- Linear programming by graphical solution
- Statistical inferences- Methods of least square and multiple regression.
- Concept of probability, Random Variables, Binomial, Poisson and Normal distribution
- Applications, Chi- squared testand Analysis of Variance.

- Solution of Ordinary differential equations
- Solutions for Integral Equations

Assessment Details (both CIE and SEE)

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

CIE for the theory component of IPCC

1. Two Tests each of **20 Marks**
2. Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

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

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

SEE for IPCC

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

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

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

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

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

Suggested Learning Resources:

Books

1. S.D. Sharma: ―Operations Research, KedaranathRamnath& Co. Meerut.
2. Rao,S.S. ―Engineering Optimizatio, John Wiley & Sons,1996.
3. Johnson R and G Bhattacharya, "Statistics – Principles and methods"- John Wiley & sons, New york,1985
4. M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and Engg. Computation, New Age International, 2003
5. Chitkara, K.K. "Construction Project Management: Planning, Scheduling and Control", TataMcGraw-Hill Publishing Company, New Delhi, 1998.

Web links and Video Lectures (e-Resources):

- NPTEL Materials: https://nptel.ac.in/courses/111105039
- Google Books: https://www.google.co.in/books/edition/Optimization_Techniques_in_Operation_Res/JL5EFfKVoBcC?hl=en&gbpv=1&dq=optimization+techniques+india&printsec=frontcover
- YouTube Lectures: https://www.youtube.com/watch?v=84HOL_EiJ4M&list=PLLtQL9wSL16ioUvHckGCkoWq_CIvyUI0p

Skill Development Activities Suggested

- Flipped classroom activity
- Group works
- Solving Numerical
- Case study analysis

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Formulate Linear programming for obtaining solution for real world problems	L3, L4
CO2	Solve Non-linear, geometric and dynamic programming problems of civil engineering.	L3, L4
CO3	Analyze the data and characterize with regression equations and test its efficacy.	L3, L4
CO4	Solving differential equations using numerical methods	L3, L4
CO5	Solve the project management problems using CPM and PERT	L3, L4

ArtificialIntelligenceand Applications in Civil Engineering			
CourseCode	**MCV102**	CIEMarks	50
TeachingHours/Week(L:P:SDA)	2:0:2	SEEMarks	50
TotalHoursofPedagogy	25Hoursofteaching+10-12sessionsofSDA	TotalMarks	100
Credits	03	ExamHours	03.00

CourseLearningobjectives:

i. To introduce students to the fundamentals of Artificial Intelligence (AI) and its various branches
ii. To equip students with the knowledge of Machine Learning (ML) concepts, types of learning (supervised, unsupervised, and reinforcement learning), and their application in civil engineering projects.
iii. To explore the structure and function of Artificial Neural Networks (ANNs), focusing on their architecture, training, and learning processes.
iv. To introduce the concepts of fuzzy logic and its utility in dealing with uncertainty and imprecision in civil engineering systems.
v. To provide students with an understanding of computer vision, its techniques, and how it can be applied in civil engineering.

Module-1

IntroductiontoAI: Introduction to AI, definition of AI, Historical evolution of AI, AI types, brief introduction to the branches of AI, Machine learning, Natural Language processing, computer vision, robotics, expert systems, Artificial neural networks and deep learning, evolutionary computation, cognitive computing, and swarm intelligence. Applications in civil engineering in each branch of AI.

Teaching-Learning Process	Structuredlecturesonthefundamentalspreparedfromstandardbookswrittenbyeminent authorsthroughaudio-visualtechnologies,explainintroductiontoArtificialintelligence.

Module-2

Machine Learning: Introduction to ML, Machine learning process model, Conceptlearning,general-to-specificordering,versionspaces,inductivebias, general to specific ordering, introduction to different kinds of machine learning, supervised, unsupervised, semi supervised, reinforcement, transfer learning and federated learning. The related algorithms under each type of ML, Applications of different ML techniques in Civil Engineering. Well posed learning problem, designing a learning system, examples.

Teaching-Learning Process	Structuredlecturesonthefundamentalspreparedfromstandardbooks and research publications related to ML applications in Civil Engineering and throughaudio-visualtechnologies.intelligence.

Module-3

Artificial neural networks (ANN): Introduction,biological motivation,appropriate problems in ANN learning**, perceptron's**,the representational power of perceptions, multilayer networks, back propagation. Introduction to recurrent neural networks, and deep learning. Illustrative real-world examples on applications of neural networks in highway/ infrastructure constructionmanagement and other civil engineering domains.

Teaching-Learning Process	Use multimedia presentations to explain theoretical concepts, supported by real-world examples and case studies relevant to civil engineering.Organize computer lab sessions where students can work with ANN software tools (e.g., Neuro Intelligence, MatLab) to create, train, and evaluate neural networks.

Module-4

Learning under uncertainty and ambiguity, fuzzy logic, linguistic variables, fuzzy sets, membership functions, fuzzy set operations, fuzzy expert systems, fuzzification, defuzzification, fuzzy rules, fuzzy inferences. Fuzzy inference system, Illustrative examples of engineering applications of fuzzy logic with specific reference to civil engineering.	
Teaching-Learning Process	Use slides, diagrams, and examples to explain theoretical concepts. Emphasize real-world applications in civil engineering to illustrate the practical relevance of fuzzy logic. Organize workshops where students use software tools (e.g., MATLAB Fuzzy Logic Toolbox) to design and implement fuzzy inference systems. Provide guided exercises and real-world scenarios for practice.
Module-5	
Introduction to Computer Vision: Definition and scope, history and evolution, Image acquis ion, image representation (grey scale and color), basic operations like filtering, thresholding. Primitives of image processing, geometric primitives, 2d Transforms, 3D transforms, photometric image formation, lighting, reflectance and shading, the digital camera, sampling and aliasing. Applications of computer vision in Civil engineering.	
Teaching-Learning Process	Use multimedia presentations, diagrams, and videos to explain concepts like image acquisition, image representation, and basic operations. Emphasize the historical context and evolution of computer vision. Present case studies that showcase the use of computer vision in areas like infrastructure inspection, construction monitoring, and urban planning. Discuss the challenges and benefits of these applications.

AssessmentDetails(bothCIEandSEE)

TheweightageofContinuousInternalEvaluation(CIE)is50%andforSemesterEndExam(SEE)is50%.Theminimumpassingmarkforthe CIEis50%ofthemaximummarks.MinimumpassingmarksinSEEis40%ofthemaximummarksofSEE.Astudentshallbedeemedtohavesatisfiedtheacademicrequirementsandearnedthecreditsallottedtoeachsubject/courseifthestudentsecuresnotlessthan50%(50marksoutof100)inthesumtotaloftheCIE(ContinuousInternalEvaluation)andSEE(SemesterEndExamination)takentogether.

ContinuousInternalEvaluation:

19. ThreeUnitTestseachof**20Marks**
20. Twoassignmentseachof**20** or oneSkillDevelopmentActivityof40marks toattaintheCOsandPOs

Thesumofthreetests,twoassignments/skillDevelopmentActivities,willbe**scaleddownto50marks**
CIEmethods/questionpaperisdesignedtoattainthedifferentlevelsofBloom's taxonomyaspertheoutcomedefinedforthecourse.

SemesterEndExamination:

TheSEEquestionpaperwillbesetfor100marksandthemarksscoredwillbeproportionatelyreducedto50.Thequestionpaperwillhavetenfullquestionscarryingequalmarks.

- Eachfullquestionisfor20marks.Therewillbetwofullquestions(withamaximumoffoursub-questions)fromeachmodule.
- Eachfullquestionwillhaveasub-questioncoveringallthetopicsunderamodule.

Thestudentswillhavetoanswerfivefullquestions,selectingonefullquestionfromeachmodule

SuggestedLearningResources:

Books:

1. Margaret A Boden, Artificial Intelligence, Academic Press London, 1996.
2. Stuart Russel, Peter Norvig, Artificial Intelligence- A modern approach, II Edition, Pearson Education, 2003.
3. Tom.M.Mitchel, Machine Learning, Indian Edition, Mc_Graw Hill, 2017
4. Timoty.J.Ross , Fuzzy Logic and Engineering Applications, III edition, Wiley Publications, 2011.
5. Richard Selizski, Computer Vision –Algorithms and Applications, Spinger Publications, 2011
6. Kothari DwarkadasPralhaddas, SamuiPijush, Artificial Intelligence in Civil Engineering, Lambert Academic Publishing, 2012.
7. Nikos D. Lagaros and VagelisPlevris, Artificial Intelligence Applied in Civil Engineering, MDPI, 2022.
8. Paul D.Harrison, Artificial Intelligence Applications in Material Science and Engineering, Kindle Edition, 2023.

Weblinksfor E-Resources(e-Resources):

https://www.researchgate.net/publication/383094533_Artificial_Intelligence_and_Applications_in_Civil_Engineering_Module_1
https://www.researchgate.net/publication/383669419_AI_and_Applications_in_Civil_Engineering_Module_2_Machine_Learning
https://www.researchgate.net/publication/383951466_AI_for_Civil_Engineers_Module_3_ANNs
https://www.researchgate.net/publication/384246445_AI_for_Civil_Engineers_Module_4_Dealing_with_Uncertainty
http://digimat.in/nptel/courses/video/106106213/L01.html
http://digimat.in/nptel/courses/video/106106198/L01.html

Course Outcomes(COs): After the completion of the course, students will be able to:

CO1: Gain insights into the role of AI in modern civil engineering practices and how it can enhance decision-making and efficiency.

CO2: Use the Acquired knowledge of basic Machine Learning algorithms and techniques and develop the ability to implement and evaluate ML models for solving complex civil engineering problems.

CO3: Comprehend the structure and functioning of Artificial Neural Networks, including various architectures and learning algorithms, and apply ANN techniques to model and solve real-world civil engineering problems.

CO4:Apply the principles of Fuzzy Logic and apply the same in handling uncertainty and imprecision in Civil engineering problems.

CO5: Implement computer vision and image processing techniques, and be able to implement computer vision methods for automated inspection, monitoring, and assessment of civilinfrastructure.

Building Information Modelling (BIM)			
Course Code	MCV103	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	25 Hours of teaching +10-12 sessions of SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To provide a comprehensive understanding of Building Information Modelling (BIM), including its significance in the architecture, engineering, and construction (AEC) industry, and familiarize students with international and national BIM standards, protocols, and execution plans.
- To introduce various BIM software tools and their applications in different phases of a project lifecycle and educate students on the processes and challenges of implementing BIM in real-world projects.
- To explore the use of BIM in the design, construction, operation, maintenance, and renovation phases of a project, highlighting the importance of collaboration and coordination among different disciplines using BIM.
- To delve into advanced BIM topics such as sustainable design, infrastructure projects, emerging technologies, and future trends.
- To cover the management strategies, educational needs, and best practices in BIM, enabling students to effectively manage BIM projects and develop educational programs.

Module-1	
Introduction to BIM Understanding BIM Definition and Importance of BIM, Historical Development of BIM, Key Concepts and Terminology BIM Standards and Protocols International BIM Standards, National BIM Standards, BIM Execution Plans (BEP) and Protocols BIM Software and Tools Overview of Popular BIM Software (e.g., Revit, Lumion), Comparison of Different BIM Tools, Introduction to BIM Interoperability BIM Implementation Process Steps in Implementing BIM in Projects, Challenges and Barriers in BIM Adoption, Case Studies of Successful BIM Implementation	
Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Solving numerical, Assignments

Module-2	
BIM in Project Lifecycle BIM in Design Phase Role of BIM in Architectural Design, Collaboration between Architects and Engineers, Design Visualization and Analysis using BIM BIM in Construction Phase BIM for Construction Planning and Management, 4D BIM (Time Dimension) and 5D BIM (Cost Dimension), Construction Simulation and Sequencing BIM in Operation and Maintenance BIM for Facility Management, Integrating BIM with Building Management Systems (BMS), Lifecycle Asset Management using BIM BIM for Renovation and Retrofit Projects BIM for Existing Buildings and Infrastructure, Challenges in Using BIM for Renovation, Case Studies of BIM in Renovation Projects	
Teaching-Learning Process	Black-Board Teaching, Solving numerical, Group work and Assignments

Module-3	
BIM Collaboration and Coordination, BIM Collaboration Techniques Collaborative Design and Engineering, Communication and Data Sharing in BIM Projects, Role of Common Data Environment (CDE) BIM Coordination and Clash Detection Coordination between Different Disciplines, Clash Detection and Resolution Techniques, Tools for BIM Coordination (e.g., Navisworks) BIM and Integrated Project Delivery (IPD) Principles of IPD, Benefits of IPD with BIM, Case Studies of BIM in IPD Projects Legal and Contractual Aspects of BIM BIM in Contract Documents, Intellectual Property and Data Ownership, Risk Management in BIM Projects	
Teaching-Learning	Black-Board Teaching, Solving numerical, Group work and Assignments

Process	

Module-4

Advanced BIM Concepts BIM for Sustainable Design BIM for Energy Analysis and Simulation, Green Building Certifications and BIM, Sustainable Materials and BIM BIM for Infrastructure Projects BIM Management Roles and Responsibilities, Developing a BIM Execution Plan, BIM for Project Managers Application of BIM in Civil Engineering Projects, BIM for Transportation Infrastructure, Case Studies of BIM in Infrastructure Projects BIM and Emerging Technologies BIM and Internet of Things (IoT), Augmented Reality (AR) and Virtual Reality (VR) in BIM, Artificial Intelligence (AI) and Machine Learning in BIM Future Trends in BIM Trends Shaping the Future of BIM, BIM in Smart Cities and Digital Twins, Global Perspective on BIM Adoption

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Solving numerical, Assignments

Module-5

BIM Management BIM Management Strategies, BIM Research and Development Current Research in BIM, Future Research Directions in BIM, Opportunities for Innovation in BIM Case Studies and Best Practices Analysis of Successful BIM Projects, Lessons Learned from BIM Implementation, Best Practices in BIM Management and Execution

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Solving numerical, Flipped classroom, Assignments

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

1.Three Unit Tests each of **20 Marks**

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

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

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

Semester End Examination:

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

1. Each full question will have a sub-question covering all the topics under a module.
2. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. "BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers" by Chuck Eastman, Paul Teicholz, Rafael Sacks, and Kathleen Liston.
2."Building Information Modeling: Planning and Managing Construction Projects with 4D CAD and Simulations" by Willem Kymmell.
3. "BIM and Construction Management: Proven Tools, Methods, and Workflows" by Brad Hardin and Dave McCool.
4."Design Integration Using Autodesk Revit 2020" by Daniel John Stine and Aaron Hansen.

5."Practical BIM: Auditing Implementations for Conformance to Industry Standards" by Cameron Warren.

Web links and Video Lectures (e-Resources):

Skill Development Activities Suggested

- Flipped classroom activity
- Group works
- Case study analysis

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Demonstrate a thorough understanding of BIM concepts, history, and terminology, and apply international and national BIM standards and protocols effectively in projects.	L3, L4
CO2	Utilize various BIM software tools for different project phases, ensuring interoperability among them, and develop and execute a BIM implementation plan, addressing challenges and barriers.	L3, L4
CO3	Apply BIM techniques in the design, construction, operation, maintenance, and renovation phases of a project, and facilitate effective collaboration and coordination among project stakeholders using BIM tools and techniques.	L3, L4
CO4	Analyze and implement advanced BIM concepts such as sustainable design, infrastructure projects, and emerging technologies.	L3, L4
CO5	Manage BIM projects effectively, develop educational programs, and apply best practices in BIM management and execution.	L3, L4

Ground Improvement Technique			
Course Code	**MCV114A**	CIEMarks	50
TeachingHours/Week(L:P:SDA)	02:00:02	SEE Marks	50
Total HoursofPedagogy	25 Hours of teaching +10-12 sessions of SDA	Total Marks	100
Credits	03	ExamHours	03

Courseobjectives:

- To gain a deep understanding of advanced ground improvement methods, including preloading, sand drains, stone columns, MSE walls, and landfill design.
- To develop skills in designing and analyzing ground improvement solutions for complex geotechnical problems.
- To engage in research-oriented learning, critically evaluating recent advancements and innovations in ground improvement techniques.

MODULE-1

Introduction to Advanced Ground Improvement –Overview of traditional and modern ground improvement methods. Selection criteria for different techniques in various geotechnical contexts Case-based learning: Analysis of landmark ground improvement projects

Advanced Mechanical and Chemical Stabilization- High-energy impact and deep compaction methods. Dynamic compaction and its applications. Introduction to chemical stabilization: Principles and mechanisms. Lime stabilization: Applications, benefits, and challenges. Applications of biochemicals in soil stabilization. Use of fly ash, slag, and other industrial by-products in soil stabilization

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation and Video Lecture.

MODULE-2

Preloading and Drainage Techniques Purification – Preloading: Concepts, design principles, and applications. Sand drains: Design, installation, and case studies. Prefabricated vertical drains (PVDs): Design and application. Field monitoring and performance assessment of preloading with drains

Hydraulic Modification and Consolidation- Advanced dewatering techniques for high-water table environments. Vacuum consolidation: Theory, design, and applications. Electro-osmosis: Mechanisms, design considerations, and recent innovations

Teaching-Learning Process	Chalkand Talk, PowerPoint Presentation and Video Lecture.

MODULE-3

Geosynthetic Materials in Ground Improvement- Introduction to geosynthetics: Types and manufacturing processes. Material properties: Tensile strength, durability, creep, and chemical resistance. Applications in ground improvement: Reinforcement, filtration, drainage, and containment. Permittivity (cross – plane plane permeability) and Transmittivity (in – plane permeability) Concepts, testing, and applications in drainage design. Design considerations for geosynthetics in soil reinforcement, erosion control, and environmental protection. Case studies of geosynthetic applications in complex geotechnical projects

Stone Columns and Ground Reinforcement Techniques – Stone columns: Overview, Design, installation, and applications in soft soils. Introduction to geosynthetic encased stone columns (GESC) . Advances in coupling GESC with electro-kinetic method. Effect of GESC on consolidation

Teaching-Learning Process	ChalkandTalk,PowerPointPresentationandVideo Lecture.

MODULE-4
Design of Mechanically Stabilized Earth (MSE) Walls- Design of geotextile walls Design principles of MSE walls: Reinforcement types and configurations. Applications of geosynthetics (Geogrids, geotextiles, geonets, and geocells) in MSE Walls Analysis of MSE wall against external and internal stability. Design problems of MSE walls as per IRC – 102. Considering modular blocks, vertical panels

Teaching-Learning Process	ChalkandTalk, PowerPoint Presentation and Video Lecture.

MODULE5
Scope of ground improvement techniques in Geoenvironmental engineering – Landfill site selection and geotechnical considerations. Design of landfill liners and covers. Introduction to CCL and GCL. Applications of HDPEs in ponds, reservoirs and canals **Sustainable Geoenvironmental engineering practices** -Overview, unsustainable actions and events, renewable geoenvironmental engineering practice. Impact of ground improvement on soil and groundwater quality. Renewable Geoenvironmental natural resources. Water and soil quality indicators. Sustainability practice examples (rehabilitation of airport land, sustainable mining conservation, agriculture sustainability study, petroleum oil well development)

Teaching-Learning Process	Chalkand Talk, PowerPoint Presentation and Video Lecture.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

1.Three Unit Tests each of 20 Marks

2.Two assignments each of 20 Marks or one Skill Development Activity of 40 marks

to attain the COs and POs

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

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

Semester End Examination:

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

Courseoutcome(CourseSkillSet) At the end of the course the student will be able to:		
Sl.No.	**Description**	
CO1	**Understanding Ground Improvement Methods**: To provide students with a comprehensive understanding of various ground improvement techniques, including their principles, methods, and applications.	
CO2	**Design and Analysis Proficiency**: To equip students with the ability to design and analyze ground improvement systems such as MSE walls and landfills, considering factors like soil type, load-bearing requirements, and environmental conditions.	
CO3	**Practical Application of Techniques**: To develop students' skills in applying ground improvement methods like preloading, sand drains, and stone columns in real-world geotechnical engineering projects.	
CO4	**Problem-Solving in Complex Geotechnical Scenarios**: To enable students to identify and solve complex geotechnical problems using appropriate ground improvement techniques, ensuring stability and sustainability in construction projects.	
CO5	**Environmental and Safety Considerations**: To raise awareness of the environmental impacts and safety considerations associated with ground improvement techniques, promoting sustainable and responsible engineering practices.	

Materials characterization			
Course Code	**MCV114B**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of teaching +10-12 sessions of SDA	Total Marks	100
Credits	3	Exam Hours	3

Course Objectives:

This course will enable students to

- Understand themorphology and composition at Micro and Nano level Metrial
- Study Pavement Materials – Soil sub grade, Base layers material characterization. Characterization of bituminous binders: different types, properties and uses
- Study the Non-renewable sources of energy and Environmental aspects.
- Understand the sustainable materials used in construction.
- 5. Understand the various aspects of Geotechnical components, and Geological structures.

MODULE-1

Basics of tools employed in understanding the morphology and composition at Micro and Nano level– SEM, XRD, EDAX; sample preparation, interpretation of results for specific applicationsIn-situ testing of materials/components – Basics of Non-destructive testing – ultra-sonic pulsevelocity tests, rebound hammer test, carbonation test, corrosion test using half-cell potentiometertest, core-sample extraction and preparation for lab test. Interpretation of results for specificperformance parameters.

Teaching-Learning Process	**Black board, LCD, Skill enhancement through problem solving, Industry visits to understand Green building ratings system.**

MODULE-2

Pavement Materials – Soil sub grade, Base layers material characterization. Characterization of bituminous binders: different types, properties and uses, physical tests on bitumen, Rheological and pavement performance related properties, Modified binders, criteria for selection of different binders, Bituminous mixes, types, requirements, properties, tests, Marshall Method of mix design Criteria and super pave mix design, Additives & Modifiers to binders. Portland cement and cement concrete for use in road works – requirements, OPC as per IS 269: 2015, design of mix for CC pavement as per BIS standards, use of additives / admixtures, joint filler and sealer materials and their characterization.

Alternate and New materials: Reclaimed Asphalt Pavement, Fly Ash, Slag, GGBS and other marginal materials & waste materials, Characteristics and application in road construction. Pavement stabilisation using innovative and sustainable materials. Concept of Value Engineering in Infrastructure engineering.

Teaching-Learning Process	**Black board, LCD, Skill enhancement through problem solving, Construction site visits to understand the nature of Alternative Building Materials**

MODULE-3

Carbon cycle and role of construction material such as concrete and steel, etc. CO2 contribution from cement and other construction materials. Control of energy use in building,ECBC code, codes inneighboringtropicalcountries,featuresof LEED and TERI Griha ratings, Performance ratings of green buildings

Non-renewable sources of energy and Environmental aspects – energy norm, coal, oil ,natural gas, Nuclear energy, Global temperature, Green house effects, global warming. Acid rain - Causes, effects and control methods. Regional impacts of temperature change

Teaching-Learning Process	**Black board, LCD, Skill enhancement through problem solving, Construction site visits to understand the nature of Special Concretes**

MODULE-4

Factors influencing nature and formation of soils. Soils as a multiphase material, Complexity of soil nature, Typical soil deposits with special reference to Indian soils. Basic engineering properties of different soils and their uses. Study of rocks: Formation, basic types of rocks, igneous, sedimentary, metamorphic rocks and their classification. Geological structures: Folds, faults and joints, their classification, criteria for the identification of faults and other discontinuities.	
Teaching-Learning Process	**Black board, LCD, Skill enhancement through problem solving, Construction site visits to understand the nature of Sustainable materials**
MODULE 5	
Sustainability index parametersUnderstanding the Embodied energy, carbon dioxide emission, global warming potential ofmaterials, Re-use and recycle potential of common building materials	
Teaching-Learning Process	**Black board, LCD, Industry visits to understand Non-renewable sources of energy and Environmental aspects**

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

1.Three Unit Tests each of 20 Marks

2.Two assignments each of 20 MarksoroneSkill Development Activity of 40 marks

to attain the COs and POs

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

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

Semester End Examination:

1.The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

2.The question paper will have ten full questions carrying equal marks.

3.Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

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

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

Suggested Learning Resources:

Text Books:

1. Materials and the environment Eco-informed material choice, Michael F Ashby, Elsevier Inc., 2009

2. GRIHA Version 2019 Manual (VOLUME I), GRIHA Council and The Energy and Resources Institute, 2021

3. Soil Behavior and Critical State Soil Mechanics Wood, D.M (1991)-cambridge university press 3. 4. Soil Mechanics SI version- Lambe, T. W. and Whitman, R. V, John Wiley &Sons.(4011)

Reference Book.

1. "**National Building Code of India - 2005** ", Bureau of Indian Standards, BIS, New Delhi.

2. Geotechnical Engineering- Donold P Coduto Phi Learning Private Limited, New Delhi

Web links and Video Lectures (e-Resources):

- **https://swayam.gov.in**
- **https://nptel.ac.in**
- **http://elearning.vtu.ac.in**

Skill Development Activities Suggested

- Visit Construction site to understand Lighting and Ventilation provisions, Natural and artificial lighting
- Visit site to understand Electrical services in the building, Technical terms and symbols for electrical installations

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Manage different types Micro and Nano level Metrial	L2,L3,L4,L5
CO2	Synchronize the construction activities with Soil sub grade, Base layers material characterization	L1,L2,L3,L6
CO3	Select the suitable Non-renewable sources of energy and Environmental aspects	L1,L2,L3,L6
CO4	Select the sustainable materials used in construction depending upon necessity and requisite budget	L2,L4,L5,L6
CO5	Apply advanced software in geotechnical aspects	L2,L4,L5,L6

Program Outcome of this course

Sl. No.	Description	POs
1	Analyze different types Micro and Nano level Metrial	1
2	Design – Soil sub grade, Base layers material characterization	4
3	Analyze Non-renewable sources of energy and Environmental aspects	5
4	Analyze suitable sustainable materials used in construction	6
5	Analyze the various aspects of Geotechnical components, and Geological structures	7
6	Engage in critical thinking and provide solution for various civil engineering problems, in industry	8

Non-Destructive Testing for Civil Engineering			
Course Code	MCV114C	**CIE Marks**	50
Teaching Hours/Week(L:P:SDA)	2:0:2	**SEE Marks**	50
Total Hours of Pedagogy	25 Hours of teaching +10-12 sessions of SDA	**Total Marks**	100
Credits	3	**Exam Hours**	03

Course Learning objectives: Thiscoursewillenablestudentsto

- To impart knowledge on various Non-destructive testing techniques and their applications in Civil engineering processes and structures.
- To teach principles of various NDT methods
- Demonstrate NDT equipment and procedures
- Explore applications in civil engineering processes and structures

Module-1

Introduction and Management of NDT activities

Role of NDT in material science, Nature, Definition, Purpose and Importance Advantages and limitations of NDT, Various NDT Methods - Principles and applications and limitations of Management of NDT Processes.

Teaching-LearningProcess	Black board, LCD, Skill enhancement through problem solving, Construction site visits to understand the nature of Sustainable materials

Module-2

Surface NDT methods

Visual Testing: Requirements, Equipment, for lab in situ and Remote Visual Testing, Visual inspection of welds, and visual acceptance standards

Penetrant Testing: types, procedures, test equipment, sensitivity indicators, flaw evaluation, ASME Acceptance standards, Advantages and limitation. Studying the working principles of Rebound Hammer.

Magnetic Testing: Types, procedures test equipment ASME Acceptance Standards. Advantages and limitations of applications

Eddy current Testing: Principles Types equipment advantages and limitations

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

Module-3

NDT Methods for Internal Inspection

RadiographyTesting Principles Techniques Sensitivity analysis, Equipment Radiation sources- X rays Gamma rays and neutrons, Detectors X ray films Imaging plates, Image processing Interpretation and defect evaluation Computed Tomography its advantages and disadvantages.

Ultrasonic Testing Principles its advantages and disadvantages. Equipment Techniques Probes, A B & C Scan methods, Phased array Ultrasonic testing Advantages and Limitations. Studying the working principles of UltrasonicPulvse Velocity Meter, Profometer.

Thermography: Principles equipment applications advantages, limitations and applications

Acoustic Emission : Principles, Types equipment Advantages limitations and applications

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

Module-4

NDT of Bridges and Dams:

Types of Bridges and their main issues& failure causes and preventive measures. Different NDT methods and applications concerning the Inspection of important bridge elements.

Types of Dams and their main issues& failure causes and preventive measures. Different NDT methods and applications concerning the Inspection of important dam elements.

Teaching-LearningProcess	Black board, LCD, Skill enhancement through problem solving, Construction site visits to understand the nature of Sustainable materials

Module-5

NDT of Concrete Structures

Important Case studies like Case study of Dhruva Reactor building. Residual life assessment methods in civil engineering. Study of NDT of Concrete Structures in India.

Studying the working principles of Scanning Electron Microscopy (SEM) and XRD testing methods.

Teaching Learning Process	Black board, LCD, Skill enhancement through problem solving, Construction site visits to understand the nature of Sustainable materials

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

1.Three Unit Tests each of 20 Marks

2.Two assignments each of 20 Marks or oneSkill Development Activity of 40 marks

to attain the COs and POs

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

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

Semester End Examination:

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

SuggestedLearningResources:

1. J Prasad , CG Krishnadas Nair and T Rangachari "Non destructive Testing of materials " Vol 1, 2 and 3.
2. Non destructive Testing handbook Vol 10 Non destructive Testing Overview American society for non-destructive testing
3. NDT of Bridges by Indian Railway Institute of Civil Engineering
4. Non Destructive Evaluation of Concrete structures Case study DhrvaRai, Sateesh and Dr Verde BARC
5. Methods for Predicting Remaining Life of Concrete in Structures NISTIR4954 J Clifton and Pommersheim Building and Fire Research Laboratory Gaithersburg, Maryland 20899
6. Residual Life Assessment of Concrete Structures-A Review NeethuUrs, Manthesh B S, Harish Jayaram , Dr. M N Hegde

Web links and Video Lectures(e-Resources):

Skill Development Activities Suggested

1) Identifying material properties like compressive strength, corrosion, and microstructural defects using NDT methods.

2) Documentation of the findings from NDT techniques in detailed reports, including data analysis and recommendations for further actions.

3) Data Interpretation and Diagnosis: Develop skills in interpreting NDT results, such as reading ultrasonic wave

signals, analyzing thermal images, and detecting voids or cracks.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Knowledge Gained on various Non-destructive testing techniques and their applications in Civil engineering processes and structures.	L1, L2,
CO2	Implementation of principles of various NDT methods	L3
CO3	Demonstrate NDT equipment and procedures	L4
CO4	Explore applications in civil engineering processes and structures	L3, L4
CO5	Knowledge gained on various Non-destructive testing techniques and their applications in Civil engineering structures.	L5,L6

REMOTE SENSING &GEOGRAPHICAL INFORMATION SYSTEM			
Course Code	**MCV114D**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:
Students will be able to know

- To understand basic concept & techniques of Remote Sensing and GIS.
- To acquire skills in image processing techniques and interpretation of remotely sensed data.
- To develop spatial database for its various application.
- To perform various spatial analysis related to water and land management.

MODULE-1

Module -1

1. Remote Sensing:

Remote Sensing Basic Principles: Introduction, Electromagnetic Remote Sensing Process, Physics of Radiant Energy: Nature of Electromagnetic Radiation, Electromagnetic Spectrum**;** Energy Source and its Characteristics, Atmospheric Interactions with Electromagnetic Radiation: Atmospheric properties, Absorption of Ozone, Atmospheric effects on Spectral Response Patterns**;** Energy interactions with Earth's surface materials: Spectral Reflectance Curves; Cossine Law.

Remote Sensing Platforms and Sensors: Satellite System Parameters, Sensor Parameter: Spatial Resolution, Spectral Resolution, Radiometric Resolution**;** Imaging Sensor Systems: Multispectral Imaging Sensor System, Thermal Sensing System, Microwave Imaging Systems; Earth Resources Satellites: Landsat Satellite Programme, SPOT Satellite, Indian Remote Sensing Satellite (IRS)**;** Meteorological Satellites: NOAA Satellite, GOES Satellite.

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Assignments

MODULE-2

Visual Image Interpretation: Introduction

Digital Image Processing: Introduction, Basic Character of Digital Image, Pre-processing: Geometric Correction Methods, Radiometric Geometric Correction, Atmospheric Geometric Correction**;** Image Enhancement Techniques: Contrast Enhancement**;** Spatial Filtering Techniques: Low Pass Filters, High Pass Filters, Filtering for Edge Enhancement**;** Image Transformations NDVI Transformation, PCA Transformation**;** Image Classification: Supervised Classification, Training Dataset, Unsupervised Classification.

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Skill enhancement through problem solving. image enhancement techniques using open source software.

MODULE-3

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, map making techniques using open sources GIS software.

MODULE-4

Spatial Database Management Systems: Introduction, Data Storage, Database Structure Models, Database Management system, Entity Relationship Model, Normalization.
Data Models and Data Structures: Introduction, GIS Data Model, Vector Data Structure, Raster Data structure, Geodatabase and Metadata.
Modelling Surfaces :DTM Generation, Triangulated Irregular Network (TIN), DTM Manipulation, DTM Interpretation. DTM Applications.

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Performing spatial analysis techniques using open sources GIS software.

MODULE 5

Spatial Analysis: Introduction to spatial analysis, Vector Operations and Analysis, Network Analysis, Raster Data Spatial Analysis.
Interpolation: Introduction to Interpolation, Global Methods of Interpolation, Local Methods of Interpolation.
Web GIS: Introduction, Web GIS, OGC & Web Services.

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Skill enhancement through problem solving. Understanding spatial analysis techniques using open sources GIS software.

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

Continuous Internal Evaluation:

- Three Unit Tests each of **20 Marks**
- Two assignments each of **20Marks** or **one Skill Development Activity of 40marks**
- To attain the Cos and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaleddownto50 marks**
CIEmethods/questionpaperisdesignedtoattainthedifferentlevelsofBloom'staxonomy
As per the outcome defined for the course. Semester End Examination:

- TheSEEquestionpaperwillbesetfor100marksandthemarksscoredwillbe proportionately reduced to 50.
- The question paper will have ten full questions carrying equal marks.
- Each full questionisfor20marks.Therewill be two full questions(with a maximum of four sub-questions) from each module.
- Each full question will have a sub-question covering all the topics under a module.

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

Suggested Learning Resources:
Text Books:

. M. Anji Reddy, _Remote Sensing and Geographical Information Systems'4th Edition, BS Publications.
. Kang-Tsung Chang, _Introduction to Geographic Information Systems', McGraw-Hill Book Company.

Reference Books:

1. Longley, P. A., Goodchild, M. F., Maguire, D. J., and Rhind, D. W., _Geographic Information Systems and Science', 2nd Edition, John Wiley and Sons.
2. Burrough, P. A., and McDonnell, R. A. _Principles of Geographical Information Systems', Oxford University Press, 2nd Edition.

Demers, M. N., _Fundamentals of Geographic Information Systems', John Wiley & Sons, 3rd Edition.

Web links and Video Lectures (e-Resources):

- Students are encouraged to visit SWAYAM web site where there are several Massive Open Online Courses (MOOC), http://swayam.gov.in

ISRO-IIRS outreach programme and conducting live & Interactive courses at our Institute/Organization

Skill Development Activities Suggested

- Flipped classroom activity
- Case study analysis

Group discussion / work

Course outcome (Course Skill Set)

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

Sl.No.	Description	Blooms Level
1	DevelopasoundunderstandingoftheBasicprinciplesandfunctiontechniquesofRemoteSensing& GIS.	L1,L2
2	Understandvarioustechniquesinpreparingspatialdata.	L1, L3
3	Designing&Manipulationofspatialdatabase.	L4, L6
4	AcquiringknowledgeofSpatialDataAnalysisandVisualization	L4, L5
5	Image Interpretation, Digital Image Processing, Remote Sensing Technologies	L2,L3

ENVIRONMENTAL GEOTECHNOLOGY

Course Code	**MCV115A**	CIEMarks	50
TeachingHours/Week (L:P:SDA)	02:00:02	SEE Marks	50
TotalHoursofPedagogy	25 Hours of teaching +10-12 sessions of SDA	Total Marks	100
Credits	03	ExamHours	03

CourseLearningobjectives:

- Toidentifythecausesforsoilpollutionand behavior rofthepollutants.
- Tounderstandthecurrentpracticeforwastedisposal.
- Toevaluateandremediatecontaminatedsitesandmonitortobringnaturalattenuation

Module-1

Soil-PollutantInteraction:
Introduction to geo environmental engineering – environmental cycle – sources, production and classification of waste – causes of soil pollution – factors governing soil-pollutant interaction- Physicochemical behaviour and modelling -failures of foundations due to pollutants

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation and Video Lecture.

Module-2

Characterization,StabilizationandDisposal
Safe disposal of waste – site selection for land fills – characterization of land fill sites – waste characterization – stability of land fills – current practice of waste disposal- passive contaminant system - Hazardous waste control and storage system – mechanism of stabilization -solidification ofwastes – micro and macro encapsulation – absorption, adsorption, precipitation- detoxification — organic and inorganic stabilization

Teaching - Learning Process	Chalk and Talk, PowerPoint Presentation and Video Lecture.

Module-3

TransportofContaminants:
Contaminant transport in sub surface – advection – diffusion – dispersion – governing equations– contaminant transformation – sorption – biodegradation – ion exchange – precipitation – hydrological consideration in land fill design – ground water pollution – bearing capacity of compacted fills – pollution of aquifers by mixing of liquid waste – protecting aquifers.

Teaching-Learning Process	ChalkandTalk,PowerPointPresentationandVideo Lecture.

Module-4

DetectionandTestingMethods
Methodology-reviewofcurrentsoiltestingconcepts–Proposedapproachforcharacterizationand identificationofcontaminatedgroundsoilforengineeringpurposes

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation and Video Lecture.

Module-5

RemediationofContaminatedSoils:
Rational approach to evaluateandremediatecontaminatedsites – monitorednaturalattenuation– exsitu and insitu

remediation – solidification, bio – remediation, incineration, soil washing, electro kinetics, soil heating, verification, bio venting – Ground water remediation – pump and treat, air sparging, reactive well- application ofgeo synthetics in solid waste management –rigid or flexible liners.

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation and Video Lecture.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs the sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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

Semester End Examination:

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

SuggestedLearningResources:

Books

- Daniel,B.E.,Geotechnicalpracticeforwastedisposal,ChapmanandHall,London,1993.
- Fang,H.Y.IntroductiontoenvironmentalGeotechnology,CRCpressNewYork,1997.
- Wentz,C.A.,HazardousWasteManagement,McGrawHill,Singapore,1989
- Lagrega,M.d.,Bukingham,P.L.,andEvans,J.C.,HazardousWasteManagement,McGraw Hill, Inc. Singapore, 1994.

WeblinksandVideoLectures(e-Resources):

- **https://archive.nptel.ac.in/courses/105/101/105101196/**
- **https://onlinecourses.nptel.ac.in/noc21_ag09/preview.**
- **https://www.digimat.in/nptel/courses/video/105103205/L33.html**
- **http://www.nitttrc.edu.in/nptel/courses/video/105101196/L33.html**
- **https://freevideolectures.com/course/4080/nptel-environmental-geotechnics/33**
- **https://archive.nptel.ac.in/courses/105/107/105107181/**

SkillDevelopmentActivitiesSuggested

- Gainthepracticalknowledgewithrespect tothegeotechnicalproperties

Courseoutcome(CourseSkillSet)

At theendofthecoursethestudentwillbeable to:

Sl. No.	Description	Bloom S Level
CO1	Understandcausesforsoilpollutionand behavior ofthe pollutants.	L2
CO2	Contaminants transport, detection andtesting methods.	L3
CO3	Applicationofgeosyntheticsinsolidwastemanagement	L4

DETAILED PROJECT REPORT (DPR) PREPARATION			
Course Code	**MCV115B**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40 hrs of teaching + 10- 12 sessions of SDA	Total Marks	100
Credits	3	Exam Hours	03

Course Learning objectives: This course will enable students to

- Prepare project report for new and up-gradation type road works by conducting necessary feasibility/detailed studies.
- Conduct the soil and material investigations to understand their behavior and performance.
- Perform various traffic related studies helping to finalize the project preparations and methods of forecasting traffic data.
- Analyse the social impact of road projects and also determine the economic feasibility analysis for justification of investments.
- Prepare DPR on road projects with relevant drawings and get the knowledge of tendering process for the construction.

Module-1

Introduction: Project overview, objectives, location stakeholder engagement plan, Project scope, time-lines, Investigations for preparation of project reports for new and up-gradation of roads.

Objects and scope of pre – feasibility, feasibility and detailed studies for project preparation. Typical HR structure for preparations and implementation of projects, Key Acts related to Road / infrastructure Projects. Salient features of ongoing road/ infrastructure projects in India, Stakeholder analysis and engagement, Project scope and boundaries.

Teaching- Learning Process	1. Blackboard teaching/PowerPoint presentations (if needed) 2. Regular review of students by asking questions based on topics covered in the class. 3. Compliment the understanding of case studies. 4. Engage in making mind-maps of DPR reports

Module-2

Surveys and investigations: Site investigation, topographical survey and mapping**,** finalization of horizontal alignment and vertical profile of roads, Application of GIS. geotechnical investigation, Material surveys for availability and choice of basic and alternate materials for construction and for soil stabilization. Cross drainage structures and drainage surveys, Interpretation of survey results. **Traffic forecasting**: classified traffic volume, growth rate, projected traffic for assessing roadway requirements, origin- destination characteristics and studies, road safety furniture, Mx ROAD

Teaching- Learning Process	1. Blackboard teaching/PowerPoint presentations (if needed) 2. Regular review of students by asking questions based on topics covered in the class. 3. Compliment the understanding of surveys by field demos 4. Plan for site visits for students, where pavement construction is going on. 5. Engage in conduction of traffic surveys and reporting

Module-3

Design and Engineering: Design details and specification, design standards and guidelines, Geometric design of roads: Cross sectional elements, horizontal and vertical alignment, Intersections-requirements, capacity of roads, roadway facilities: Pedestrian facilities, bus bays, truck lay byes, traffic, medical and vehicle aid posts, street lighting, Pavement design and materials, Drainage and stormwater management.

Teaching-Learning Process	1. Blackboard teaching/PowerPoint presentations (if needed) 2. Regular review of students by asking questions based on topics covered in the class.

Module-4

Environmental and Social Impact Assessment: Objectives, procedure of environmental impact assessment, socio economic survey, mitigation measures, Landscaping and tree plantation, implementation of environment management plan, Key environmental legislations, clearances required for road project- environmental, forest, CRZ, wildlife, air, noise quality standards. Social Management Plan, community engagement and participation, Conflict resolution mechanism.

Teaching- Learning Process	1. Blackboard teaching/PowerPoint presentations (if needed) 2. Regular review of students by asking questions based on topics covered in the class. 3. Compliment the understanding by discussing case studies

Module-5	
Preparation of DPR design details, estimates, BOQ, drawings and detailed project, report, use of software, **Cost Estimation and Financial Analysis**: Cost estimation methods and techniques, Financial analysis and viability, Project funding options and financing plan, Risk assessment and mitigation strategies, Public Private Partnership (PPP), environmental economics, Toll collection, economic viability PPP projects, risk analysis, case studies **Rate Analysis**: Prerequisites, factors affecting rate analysis, overhead expenses, procedure for rate analysis, schedule of rates, Task work: labour requirement for different works, material requirement for different works, Rate analysis of different Items of work. **Tendering process -** Preparation of tender documents for different types of road/infrastructure projects, Tender evaluation. Salient clauses of tender document, tender evaluation – technical and Financial.	
Teaching- Learning Process	1. Blackboard teaching/PowerPoint presentations (if needed) 2. Regular review of students by asking questions based on topics covered in the class. 3. Compliment the understanding by discussing case studies

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

3. Three Unit Tests each of **20 Marks**
4. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs the sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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

Semester End Examination:

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

Suggested Learning Resources:

Text Books:

1. L.R.Kadyali, N.B.Lal, "Principles and Practices of Highway Engineering,, Khanna Publishers

Reference Books:

1. IRC: SP:19 - 2001, Manual for Survey, "Investigation and Preparation of Road Projects"- (first revision), Indian Roads Congress
2. IRC: SP: 30 - 1993, "Manual on Economic Evaluation of Highway"- Projects in India (first revision), Indian Roads Congress
3. IRC SP – 38," Manual for Road Investment Decision Model"-1992, Indian Roads Congress
4. IRC: 9-1972, 35 – 1997,38-1988, 39-1986, 52-2001, 54-974, 62-1976, 64-1990, 66-1976, 67-2001, 69-1977, 73-1980, 79-1981, 80-1981, 86-1983, 98-1997, 99-1988, 103-1988, 104- 1988, 110-1996
5. MoRTH "Specifications for Road Bridge Works"- 2001, fourth revision, Indian Roads Congress
6. MoRTH "Standard and Bidding Document Procurement of Civil Works"- Part I and II, 2000, Indian Roads Congress
7. MoRTH "Model Concession Agreement for Small Road Projects"-2000, Indian Roads Congress

Web links and Video Lectures (e-Resources):

https://www.youtube.com/channel/UC5fUyyuRnwi7H4DPXUwW4sg

Skill Development Activities Suggested

- Prepare the BOQ of minor and major projects and compare the cost.
- Prepare excels sheets for growth factor estimation as per IRC :105-2015
- Carry out the traffic studies specific to a project and infer from the data collected
- Prepare mind-maps after studying various DPRs for Road projects to understand the various stages of DPR preparation.

Course outcome (Course Skill Set)

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

Sl. No	Description	Blooms Level
CO1	Prepare project report for new and up-gradation type road works by conducting necessary Feasibility/detailed studies.	L3
CO2	Conduct the soil and material investigations to understand their behaviour and performance	L2
CO3	Analyse the surveys and investigations and select geometry of road Understand the contract document, evaluation and contract management for road projects.	L4
CO4	Analyse the social impact of road projects and also determine the economic feasibility analysis for justification of Investments.	L3, L4
CO5	Prepare DPR on road projects with relevant drawings and get the knowledge of tendering process for the Construction	L6

Advanced Survey and Location			
Course Code	MCV115C	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40 hrs of teaching + 10- 12 sessions of SDA	Total Marks	100
Credits	3	Exam Hours	03

Course Learning objectives:

- Upon completion of this subject students should have gained the knowledge of advanced survey,
- Students will gain Geodesy, and Global Positioning System and also they become familiar with the basic principles and their applications in Geoinformatics Projects.
- The student will be able to understand the advanced survey methods, LBS and their applications in the infrastructure planning, utility mapping, etc. The student will also be able to use various platforms for spatial data acquisition.

Module-1

Geodetic control: Plane and geodetic classification, principles of survey, linear and angular measurements, Control survey; Total station traverse, Triangulation, Trilateration, Spirit levelling, Trigonometric levelling, Detailed survey; original, revision, up-dation; Geodetic Control (Horizontal and Vertical) – Geodetic co-ordinate System, Rectangular or Cartesian Co-ordinate System; Geo potential number - Orthometric height, Normal height, Dynamic height and their corrections – single and reciprocal observation of vertical angle.

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Solving numerical, Assignments

Module-2

Fundamentals of Total station: Basic principles of Total Station, Electro-optical system: Measuring principle, working principle, sources of error, Infrared and Laser Total Station instruments; Microwave system: Measuring principle, working principle, sources of error, Comparison between Electro-optical and Microwave system; Traversing and Trilateration-s/w functions, offsets and stake out-land survey applications. Applications and comparison with conventional surveying.

Teaching-Learning Process	Black-Board Teaching, Solving numerical, Group work and Assignments

Module-3

Ground Penetrating Radar (GPR): GPR system and signals, measurement configurations, bands, polarizations; Characteristics of host medium, measure of the propagation velocity in a Masonry, Homogeneous soil, Lossy, Magnetic and Dispersive media; GPR data sampling- Frequency and Time steps, shape and thickness of the GPR pulses; Diffraction tomography, horizontal resolution, vertical resolution, spatial step; application field.

Teaching-Learning Process	Black-Board Teaching, Solving numerical, Group work and Assignments

Module-4

Light Detection and Ranging (LIDAR): Principles and Properties- different LiDAR System- Space Borne and airborne LiDAR missions – Typical parameters of LiDAR system. Data Processing – geometric correction-data quality enhancement – filtering - LiDAR mapping applications: Hydrology, Disaster mitigation and management, etc.

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Solving numerical, Assignments

Module-5

Location Based Services (LBS) & Applications: Concept of location, General Aspects of Location Based Services, Navigation and positioning Systems, A Spatial Database Perspective, Middleware for Location-Based Services, Interoperability through Standards, Data Collection, Data Transmission in Mobile Communication Systems, Architectures and Protocols for LBS, Network Architecture, Functional Entities, Location Procedures, Applications of LBS.

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Solving numerical, Flipped classroom, Assignments

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

1.Three Unit Tests each of **20 Marks**

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

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

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

Semester End Examination:

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

Suggested Learning Resources:

Books

1. The Principles of Surveying - by J. Clendinning
2. Basic Survey volume I and II - Clarke
3. Introduction to Ground Penetrating Radar - Inverse Scattering and Data Processing by RaffaelePersico, Wiley.
4. Harry M. Jol (2009) Ground Penetrating Radar Theory and Applications, Elsevier Science, Amsterdam.
5. LiDAR Remote sensing and Applications – Pinliang Dong and Qi Chen
6. General Cartography - E Raisz
7. Elements of Cartography - A H Robinson & R D Sale
8. Advances in Location-Based Services – 8th International Symposium on Location-Based Services, Vienna 2011 – Georg Gartner, Felix Ortag, Editors - Springer

Course outcome (Course Skill Set)

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

The student will be able to understand the advanced survey methods, LBS and their applications in the infrastructure planning, utility mapping, etc. The student will also be able to use various platforms for spatial data acquisition.

COMPOSITE MATERIALS			
Course Code	**MCV115D**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	40 hrs of teaching + 10- 12 sessions of SDA	Exam Hours	03
Credits	03		

Prerequisites: Basic knowledge on material properties, Matrix Method of Structural Analysis and Mechanics of Deformable Bodies

Course Learning objectives:

- To impart knowledge of composite materials in the context of structural engineering application.
- To Impart a skill of analyzing macro and micro mechanical behavior of composites.
- To develop introductory knowledge about manufacturing of composites and its failure theories..

Module-1

Introduction: Introduction to Composite materials, classifications (thermoset and thermoplastic) and civil/structural engineering applications. Constituent materials of composites–Reinforcements and matrix. Rule of mixture. Selection of materials. Manufacturing techniques–Hand layup method and compression moulding method. Basics Of fiber reinforced composite (Synthetic and natural FR Polymer composites). Advantages and Limitations of composites.

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Solving numerical, Assignments

Module-2

Macro-mechanical Behaviour of a Lamina: Introduction, Stress –Strain Relations For Anisotropic Materials. Stiffness's, compliances, and engineering constants for orthotropic materials. Restrictions on engineering constants. Numerical problems.

Teaching-Learning Process	Black-Board Teaching, Solving numerical, Group work and Assignments

Module-3

Macro-Mechanical Behaviour of a Lamina contd...

Stress-strain relations for plane stress in an orthotropic material. Stress-strain relations for a lamina of arbitrary orientation. Invariant properties of an orthotropic lamina. Strengths of an orthotropic lamina, thermal and mechanical stress analysis. Numerical problems.

Teaching-Learning Process	Black-Board Teaching, Solving numerical, Group work and Assignments

Module-4

Micro-mechanical behavior of a lamina: introduction, mechanics of materials approach to stiffness. Determination of E1. Determination of E2.Determination of v12. Determination of G12. Numerical problems

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Solving numerical, Assignments

Module-5

Classicalcompositelaminationtheory, cross and angle – play laminates, symmetric, anti- symmetric and general symmetric laminates. Mechanical coupling. Analysis of simple laminated structural elements ply-stressand strain, lamina failure theories concepts – Maximum Stress Failure Criterion, Maximum Strain Failure Criterion and

Tsai-Hill Failure Criterion. Numerical Problems.

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Solving numerical, Flipped classroom, Assignments

Assessment Details (both CIE and SEE)

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

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to attain the COs and POs

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Semester End Examination:

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2. The question paper will have ten full questions carrying equal marks.

3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

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

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

Suggested Learning Resources:

Books

1.Mechanics of Composite Materials and Structures by M. Mukhopadhya-Universities Press 2009

2. Robart M. Jones, "**Mechanical ofComposite Materials**"- McGraw Hill Publishing Co.

3. Bhagwan D Agarval m, and Lawrence J Brut man, "**AnalysisandPerformanceofFiberComposites**"-John Willy and Sons.

4. AutarK.Kaw, Mechanics of Composite Materias, Second edition.,CRCPress,2006.

Web links and Video Lectures (e-Resources):
https://www.youtube.com/watch?v=0kB0G6WKhKE&list=PLSGws_74K01-bdEEUElQ9-obrujIKGEhg

Skill Development Activities Suggested

- Conduction of technical seminars on recent research activities
- Group Discussion

COMPUTATIONAL LAB		Year/Semester	
CourseCode	**MCVL106**	CIEMarks	**50**
TeachingHours/week(L.T.P.S)	**1:2:0**	SEEMarks	**50**
TotalHoursofPedagogy		TotalMarks	**100**
Credits	**2**	Exam Hours	**3**
ExaminationType(SEE)	Practical		

Course Objectives:

- **Todevelopproficiencyincreating3Dbuildingmodelsusing Revit**,enablingstudentsto set up levels, grids, and design walls, doors, and windows with accurate elevation and 3D views.
- **To enable students to create and annotate detailed floor plans** to use Revit, including dimensions, room tags, and text notes, while generating professional sheets for effective documentation.
- **To equip students with skills for generating and managing schedules** from the Revit model,suchasdoor,window,androomschedules,tostreamlineprojectmanagement.
- **To develop proficiency in constructing structural models in Revit Structure**, including beams, columns, and foundations, ensuring alignment with architectural designs.
- **To enable students to design and analyze sewer systems** using SewerGEMS, including the creation of detailed models and performing hydraulic analysis to evaluate system performance.
- **To equip students withpractical skills and theoretical knowledgeinroaddesign**using AutodeskCivil3D,focusingoncreatingsurfacemodels,designinghorizontal alignments, generating profiles, and developing road corridors.

Teaching-LearningProcess(GeneralInstructions)
Thesearesamplestrategies,whichteacherscanusetoacceleratetheattainmentofthevarious course outcomes:

1. BlackboardTeaching
2. PowerpointPresentation
3. TutorialVideos
4. HandsonPracticalSessions

Exercises

1. Basic3DBuildingInformation Modeling
   - Setupbuildinglevelsandgrids,drawwalls,insertdoors,andplacewindows.

2. Createthebuilding'sroofandfloors,placecolumnsandfootingsatgrids.
   - Generateelevationviewsand3Dviews.

3. Createcustomfamilies suchas furniture, windows, or doors inRevit.

5. Developdetailedfloorplanswithannotationssuchasdimensions,roomtags,andtextnotes.

6. Generatesheetswithproperlayoutandtitleblocks.

7. Generateschedules(e.g.,doorschedule,windowschedule,roomschedule) from the Revitmodel.

7A.Developastructuralframingmodelusingbeams,columns,andfoundationsinRevitStructure.

- Setuplevelsandgridsforthestructuralsystem.
- Addstructuralcolumnsandbeamstocreatethebuildingframe.

Or

7B.Createadetailedmodelofasewersystem

- CreateSewerNetworkModel,DefineNetworkParameters

Or

7C.CreateaSurfaceModel usingCivil3D.

- Importsurveypoints,createasurface,addbreaklines,andgeneratecontours.

8A.Placefoundationsandfootings atthebaseofcolumns.

- Reviewthe3Dstructuralframingmodelandensurealignmentwith architectural plans.

Or

8B.Performhydraulicanalysisusing SewerGEMSForthesamemodel.

- RunHydraulicSimulationsandEvaluateResults

Or

8C.DesignHorizontalAlignments usingCivil3D.

- Createalignments,editalignmentgeometry,andaddalignment labels.

9A.DetailingofColumns,Beams,andFoundationsinRevitStructure

- Createanewproject,definebuildinglevelsandgrids,DetailingStructural Components

Or

9B.DesignofsewagenetworkusingSewerGEMS.

Or

9C.GenerateProfilesandProfileViewsusingCivil3D.

- Createsurfaceprofiles,designprofiles,andgenerateprofileviews.

10A.Developdifferenttypesoffoundationandshowrebardetailing.

Or

10B.Modelreliefsewers,overflowdiversions,andinvertedsiphons.

Or

10C.CreateRoadCorridorsusingCivil3D.

CourseOutcomes(CourseSkillsSet)

AttheendoftheCoursethestudentwillbeableto:

- **create detailed 3D architectural models** using Revit, effectively visualizing building structures with precision and parametric tools.
- **generate comprehensive construction documentation** including floor plans, sections, elevations, and schedules, ensuring accurate project coordination and data extraction.
- **customizeandmanage**familycomponentsinRevit.
- construct and analyze structural framing models in Revit Structure, integrating beams, columns, and foundations while maintaining alignment with architectural plans.
- design and perform hydraulic analysis on sewer systems using SewerGEMS, creating detailed models and evaluating their performance through simulations.
- proficiently use Civil 3D to create detailed surface models from survey data, design and edit horizontal alignments that meet engineering standards, generate and analyze road profiles and profile views, and developcomprehensive road corridor models and cross-sections for engineering analysis.