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||Jai Sri Gurudev||

Sri Adichunchanagiri Shikshana Trust (R.)

SJC INSTITUTE OF TECHNOLOGY

An Autonomous Institution under VTU from 2024-25

AICTE Approved, Accredited by NAAC with A+ Grade & NBA (CSE, ISE, ECE, ME & CV), NIRF(151-300) in 2023,Gold Rated by QS I-Gauge

P.B. No.20, B.B Road, Chikkaballapur - 562 101, Karnataka

Estd : 1986

I & II Semester
Scheme & Syllabus of M.Tech Programme
Structural Engineering
(2026 Scheme)

Core Values

Spiritual, **J**udicious, **C**ommitment, **I**ntegrity, **T**rustworthy



AICTE

NATIONAL INSTITUTIONAL RANKING FRAMEWORK 151-300

NBA

A+ NAAC

QS I-GAUGE GOLD

INSTITUTION'S INNOVATION COUNCIL (Ministry of HRD Initiative) 4-Star Rating



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Sri Adichunchanagiri Shikshana Trust (R.)

SJC INSTITUTE OF TECHNOLOGY

(An Autonomus Institute Under VTU Belagavi & Approved by AICTE, New Delhi)

Accredited by NAAC with A+ Grade & NBA (CSE, ISE, ECE, ME & CV), NIRF (151-300), QS-I Gauge GOLD Rated

Post Box #20, B.B. Road, Chikkaballapur - 562 101, Karnataka

Estd.:1986

Scheme of Teaching and Examinations (2026)

1st Sem M. Tech (Specialization: Civil Structural Engineering)

Choice-Based Credit System (CBCS) and Outcome-Based Education (OBE)

I SEMESTER (Common to all specialized programmes under one stream)

Sl. No	Course Type	Course Code	Course Title	Teaching & Learning Scheme					Examination				Credits
				CI		LI	TW & SL	Total Hours/ SEM	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P							
1	MAT/ PCC	1MCV101	Advanced Engineering Mathematics and Data Analytics	42	0	0	48	90	03	50	50	100	3
2	PCC	1MCV102	Sustainable and Climate Resilient Planning and Design	42	0	0	48	90	03	50	50	100	3
3	PCC	1MCV103	AI, Machine Learning and Emerging Digital Tools	42	0	0	48	90	03	50	50	100	3
4	IPCC	1MCV104X	Integrated Professional Core Courses (IPCC) -I	42	0	28	50	120	03	50	50	100	4
5	PEC-I	1MCV105X	Professional Elective–I (Common Elective Basket)	42	0	0	48	90	03	50	50	100	3
6	PEC-II	1MCV106X	Professional Elective–II (Common Elective Basket)	42	0	0	48	90	03	50	50	100	3
7	PCCL	1MCVL107X	Professional Core Course Lab	0	0	28	02	30	03	50	50	100	1
8	NCMC	1MRMI108	Research Methodology and IPR (VTU Online Course)		Online courses (online.vtu.ac.in)								PP
								TOTAL		**350**	**350**	**700**	**20**

Professional Elective Courses (PECs):

Professional Elective Courses – PEC–I and PEC–II – are common to all branches of specialization within a particular Engineering stream. Students may choose the most appropriate elective based on their field of specialization and academic requirements. Note: The number of courses listed under each PEC group may exceed four, depending on the specializations under one stream.

Integrated Professional Core Courses (IPCC):

The 1Mxx104x Group comprises specialization-specific core courses that are integrated with a practical component, ensuring application-oriented learning aligned with industry and research needs. The number of courses in the group depends on the number of specializations offered under a particular engineering stream.

Integrated Professional Core Courses (IPCC): The 1Mxx104x Group comprises specialization-specific core courses that are integrated with a practical component, ensuring application-oriented learning aligned with industry and research needs. The number of courses in the group depends on the red under a particular engineering stream.

1MCV104X : Integrated Professional Core Course (IPCC)			**1MCV105X : Professional Elective Courses-I**	
Code	**Title of the course**		**Code**	**Title of the course**
1MCV104A	Building Information Modeling for Structural Systems		1MCV105A	Advanced Remote Sensing and GIS
1MCV104B	BIM for Construction Sequencing and Resource Modeling		1MCV105B	Applied Statistics & Uncertainty Modeling
1MCV104C	Remote Sensing and GIS for Transport Modeling		1MCV105C	Climate Change Modeling & Disaster Risk Reduction
1MCV104D	Geo BIM for Geotechnical Modeling and Underground Infrastructures		1MCV105D	Sustainable Materials & Circular Economy
1MCV104E	Geospatial Environmental Monitoring and Modeling		1MCV105E	Project Feasibility and Report Writing
1MCV104F	BIM and Hydro-GIS Modeling for River Basin Systems		1MCV105F	Sustainable Infrastructure Planning & Policy
1MCV104G	BIM for Infrastructure Engineering and Management		1MCV105G	Occupational Health and Safety Engineering
1MCV104H	Integrated BIM & Computer Aided Design for Transportation Systems		1MCV104H	Sustainable Geo-mechanics and Engineering
1MCV104I	Geospatial Database Management Systems and Programming Skills		1MCV105I	Geospatial Data Standards and Policy
1MCV104J	Retrofitting & Rehabilitation of Structures		1MCV105J	Building Cost and Quality Management

1MCV106X: Professional Elective Courses-II			**1MCV107X: Professional Core Course Lab (PCCL)**	
Code	**Title of the course**		**Code**	**Title of the course**
1MCV106A	Digital Twin Technologies		1MCVL107A	Computational Structural Modeling and Analysis Laboratory
1MCV106B	Optimization Techniques for Civil Systems		1MCVL107B	BIM-based Planning and Scheduling Laboratory
1MCV106C	Smart Cities & Urban Analytics		1MCVL107C	GIS-based Alignment and Traffic Analytics Laboratory
1MCV106D	Robotics & Automation in Construction		1MCVL107D	Geotechnical Engineering Studio
1MCV106E	IOT and Smart Sensors for Civil Engineering		1MCVL107E	Hydraulic and Wastewater Network Modeling Laboratory
1MCV106F	Smart Solid Waste Management and Circular Economy Systems		1MCVL107F	Watershed and Irrigation Network Modeling Laboratory
1MCV106G	Cloud Platforms & Big Data for Geospatial Applications		1MCVL107G	BIM for Buildings and Infrastructure Modeling
1MCV106H	Special Concrete		1MCVL107H	Digital Satellite Image Processing Lab
			1MCVL107I	Non-Destructive Testing Laboratory

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- **Overview of Courses, Credits, Projects, and Internships under MTech - 2026 Curriculum**

(A) Abbreviations Adopted in the Scheme of Teaching and Examinations

Course		General Terms		General Terms	
Acronyms	**Expanded Form**	**Acronyms**	**Expanded Form**	**Acronyms**	**Expanded Form**
AEC	Ability Enhancement Course	AICTE	All India Council of Technical Education	SEE	Semester End Evaluation
ASC	Applied Science Course	CCA	Continuous Comprehensive Assessment	SGPA	Semester Grade Point Average
BSC	Basic Science Course	CGPA	Cumulative Grade Point Average	SL	Self-Learning
HSMC	Humanities Studies and Management Course	CI	Classroom Instruction	SWAYAM	Study Webs of Active-Learning for Young Aspiring Minds
IPCC	Integrated Professional Core Course	CIE	Continuous Internal Evaluation	T	Tutorial
NCMC	Non-Credit Mandatory Course	COE	Centre for Online Education	TW	Term Work
OEC	Open Elective	CUL	Cultural	VTU online	VTU online courses
PCC	Professional Core Course	NCrF	National Credit Framework		
PCCL	Professional Core Course	L	Lecture		
PEC	Professional Elective	LI	Laboratory Instruction		
PE	Physical Education	NPTEL	National Programme for		
SEC	Skill Enhancement	NSS	National Service Scheme		
YOG	Yoga	P	Practical		

(A) Academic Credit Framework in accordance with the National Credit Framework (NCrF)

The National Credit Framework (NCrF), introduced under India's education reforms, serves as an umbrella framework for the creditisation of learning across school education, higher education, vocational education, and experiential learning.

NCrF credit levels are determined based on a combination of cumulative years of learning, the complexity of learning outcomes, and the rigor of assessment. These levels signify the degree of competence and complexity attained by the learner, progressing from foundational schooling to advanced doctoral research.

Levels 1 to 4 correspond to school education up to the 12th standard, while Levels 4.5 to 8 correspond to higher education, ranging from the undergraduate level to the Ph.D. level.

In the earlier system, credits were primarily based on contact time (lecture hours per week × number of weeks per semester/year), assuming that learning is directly proportional to time spent in classroom instruction.

However, the NCrF adopts a comprehensive and outcome-based approach by assigning credits to all forms of learning, including, (i) Classroom teaching, (ii)Laboratory work, (iii)Projects, (iv)Internships and apprenticeships, (v)Online and blended learning, (vi)Fieldwork and community engagement, (vii)Recognition of Prior Learning (RPL), (viii)Sports and arts activities, and (ix)On-the-job training.

Credits are thus based on notional learning hours, representing the total learner effort rather than only contact hours. This definition aligns Indian education with Global outcome-based credit systems, and international credit transfer practices [e.g., European Credit Transfer and Accumulation System (ECTS)-like frameworks].

According to NCrF, one academic year of learning is equal 1,200 notional learning hours (not a scientifically-validated law or psychological constant, but a policy design hours) and includes classroom teaching, self-study, assignments, projects, laboratory work, co-curricular and extra-curricular activities, internships, apprenticeships and other assessed learning experiences. For these 1,200 hours a student is expected to earn 40 credits, which means 1 credit corresponds to approximately 30 hours of academic learning.

Although traditional university systems often equated 1 credit with approximately 13 to15 contact hours per semester, VTU, in alignment with NCrF, considers 14-weeks of structured academic interaction per semester with students is equivalent to approximately 30 notional hours per credit.

The learning methodologies include:

(i) **Classroom Instruction (CI):** Includes different instructional/implementation strategies, such as Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc., to deliver theoretical concepts within the classroom measured in Number of hours per semester.

(ii) **Laboratory Instruction (LI):** Expressed as number of hours per semester which Includes

(iii) experiments/practical performances / problem-based experiences in laboratory, workshop, field or other locations using different instructional / Implementation strategies.

(iv) Term work (TW): Includes assignments, seminars, presentations, case studies, micro projects, field activities, industrial visits, academic preparation duration and any other student activities in Number of hours per semester.

(v) Self-Learning (SL): MOOCs (SWAYAM/NPTEL/Industry certified courses), spoken tutorials, online educational resources, self-initiated projects, Learning through digital resources etc in Number of hours per semester.

VTU, in alignment with NCrF, considers 14-weeks of structured academic interaction per semester with students as equivalent to approximately 30 notional hours per credit.

Table below shows the credit structure, equivalent NCrF learning hours adopted by VTU:

Table 7.0.1 VTU adopted NCrF credit structure

Particulars	Classroom Instruction (CI) in Hours per semester		Laboratory Instruction (LI) in Hours per semester	Term work (TW) and Self-Learning (SL) in Hours per semester	Total number of Teaching-Learning hours per semester
	L	T	P	TW + SL	
1 Credit theory course	14	-	-	16	30
1 Credit Practical course	-	-	28	02	30
2 Credit theory course	28	-	-	32	60
3 Credit theory course	42	-	-	48	90
3 Credit theory course with Tutorial	28	28	-	34	90
4 Credit theory course	56	-	-	64	120
4 Credit theory course with Tutorial	42	28	-	50	120
4 Credit Integrated Course	42	-	28	50	120
Project work	-	-	-	As per the type of project	
Internship	-	-	-	As per the type of Internship	

NCrF is designed to work with ABC for years, where, credits are digitally stored to accumulate, transfer, and redemption across institutions for vertical and horizontal mobility across sectors, which is essential for MEME.

(B) Details of Courses

(1) **Integrated Professional Core Course (IPCC):** The Integrated Professional Core Course (IPCC) refers to a core theory course that is integrated with a laboratory of the same subject. Each IPCC carries 4 credits, with Teaching–Learning hours structured (L : T : P) as either (3:0:2). The theory component of the IPCC shall be evaluated through both Continuous Internal Evaluation (CIE) and Semester End Examination (SEE). The laboratory part shall be assessed exclusively through CIE, with no SEE. However, questions derived from the laboratory part may be included in the SEE question paper to ensure comprehensive evaluation.

(2) **Non-Credit Mandatory Courses (NCMC):** are aimed at enhancing students' knowledge, skills, and awareness beyond the core curriculum. Successful completion of the NCMC is compulsory for fulfilling the requirements of the academic program. It shall not be considered for the computation of SGPA, CGPA and vertical progression. Each student shall register for the prescribed NCMC(s) in the prescribed semester. A student who fails to qualify in the prescribed NCMC shall not be eligible for the conferment of the degree.

(3) **Professional Elective Courses (PEC):** A professional elective course (PEC) is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum of the same discipline.

(4) **Open Elective Courses (OEC):** A open elective course (OEC) is a course offered by departments other than a student's parent department. These interdepartmental /interdisciplinary courses allow students to explore disciplines beyond their core area of study. These courses are intended to promote interdisciplinary learning, broad-based education, thereby enhancing a student's overall knowledge, creativity, and employability. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor/Proctor.

(5) **Ability/Skill Enhancement Course Laboratory (AEC):** An Ability Enhancement Course Laboratory is a practical, skill-oriented lab course designed to strengthen students' practical abilities, professional competencies that support communication, environmental awareness, computational thinking, interdisciplinary learning, and application skills through hands-on learning experiences.
The laboratory may pertain to disciplinary or interdisciplinary involving experiments, design tasks, and mini-projects aligned with current industry practices.

(6) **Skill Enhancement Courses (SEC):** These courses are intended to develop specific practical skills and competencies that improve students' employability, technical proficiency, and professional readiness to bridge the gap between academic and industry requirements. These courses emphasize hands-on training,

application of theoretical knowledge, and development of discipline-relevant and transferable skills required in industry and society, and develop entrepreneurship and start-up skills.

(7) **Online Courses:** Online courses are educational programs delivered over the Internet through a digital platform, allowing students to access lessons, assignments, and discussions from anywhere at any time. Most online courses offer flexibility, allowing students to access materials and complete assignments on their own schedule. However, students have to pass the course within a stipulated period as per the norms of the university.

(8) **VTU Online Courses:** VTU Online Courses are online courses offered by the Centre of Online Education (COE), Mysuru. A wide range of multidisciplinary courses is made available to learners anytime and anywhere, enabling them to earn University-prescribed credits through duly conducted proctored examinations for the award of the degree.

NPTEL/SWAYAM courses adopted by VTU shall be offered in accordance with the NPTEL/SWAYAM course delivery framework, wherein teaching–learning is carried out through the online MOOC platform, assignments are administered periodically, and assessment is completed through a centrally conducted proctored examination as prescribed by the respective platform.

(9) **NPTEL/SWAYAM Online Courses:** The National Programme on Technology Enhanced Learning (NPTEL)/SWAYAM (Study Webs of Active Learning for Young Aspiring Minds) are the specific Indian platforms to host national Massive Open Online Courses (MOOCs). It offers online courses on a wide range of disciplines to learners anywhere, anytime, to earn university-prescribed credits through proctored examination for the award of a degree. All NPTEL/SWAYAM courses are MOOCs, but not all MOOCs are offered on these specific Indian platforms.



Semester: I						
ADVANCED ENGINEERING MATHEMATICS AND DATA ANALYTICS						
Course Code	**:**	1MCV101		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50 Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50 Marks
Course Type	**:**	PCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Engineering Mathematics, Engineering Statistics and Basic Programming/Python
Knowledge on Fundamental Concepts	Basic knowledge of algebra, calculus, probability and statistics
Knowledge on Connected Tools (If any)	Basic Python programming

Course Learning Objectives: This course will enable the students to	
CLO1	Apply linear algebra, matrices, eigenvalues, eigenvectors and quadratic forms to engineering and structural problems.
CLO2	Solve ordinary and partial differential equations using analytical methods for engineering applications.
CLO3	Apply probability, statistics and data visualization techniques to interpret engineering data using Python.
CLO4	Apply numerical methods and optimization techniques to solve engineering equations and optimization problems.
CLO5	Analyze engineering data using regression, PCA, Laplace and Fourier transforms, and time-series techniques for civil engineering applications.

Module-1	**No. of Hrs:8 hrs**
Linear Algebra and Matrix Applications: Vectors, Linear dependence and linear independence vectors, linear transformations, eigenvalues and eigenvectors for vibration analysis; Consistency of a system of equations, Systems of linear equations by Gauss elimination method. Quadratic forms in structural optimization; Applications: truss analysis, finite element basics. **Text Book 1:** Ch. 7, 8 **Text Book 2:** Ch. 8, 9, 13	
Module-2	**No. of Hrs:9 hrs**
Solutions on Ordinary and Partial Differential Equations: First-order ODEs (exact, integrating factors); Higher-order linear ODEs with constant coefficients; Power series/Frobenius methods; PDEs: separation of variables method, Various possible solutions for wave and heat equations. **Text Book 1:** Ch. 1, 2, 3, 5, 12 **Text Book 2:** Ch. 22, 23, 24	
Module-3	**No. of Hrs:9 hrs**
Probability, Statistics & Data Visualization: Probability distributions: Binomial, Poisson, normal distribution for success and failure rates. Descriptive statistics, hypothesis testing; Data visualization (histograms, boxplots) with Python (Matplotlib, Seaborn) **Text Book 1:** Ch. 24, 25 **Text Book 2:** Ch. 2, 14	

Text Book:3 Ch. 3, 4, 6, 8, 9	
Module-4	**No. of Hrs:8 hrs**
Numerical Methods & Optimization: Root of transcendental equations: Regula false and Newton-Raphson methods. Lagrange Interpolation and splines Interpolation, Optimization: unconstrained optimization and constrained optimization: Lagrange multipliers. **Text Book 1:** Ch. 19, 22 **Text Book 2:** Ch. 5, 6, 7, 17, 18	
Module-5	**No. of Hrs:8 hrs**
Regression, Multivariate Analytics & Transforms: Linear and multiple regressions model, problems relevant to civil engineering. PCA for dimensionality reduction; Laplace and Fourier transform for signal processing in monitoring; Time-series basics (ARIMA for traffic). **Text Book 1:** Ch. 6, 11, 14, 15, 24, 25 **Text Book 2:** Ch. 14, 15, 16 **Text Book 3:** Ch. 11, 12	

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply linear algebra and matrix methods to civil engineering problems like structural analysis.
CO2	Solve ODEs/PDEs for modeling vibrations, diffusion in infrastructure systems.
CO3	Analyze multivariate data using statistical methods and visualization for civil datasets.
CO4	Implement numerical methods and optimization for data analytics in engineering.
CO5	Evaluate statistical models, regression, hypothesis testing, and Fourier and Laplace transforms for construction quality control and sustainable design.

Text Books	
1	Erwin Kreyszig, Advanced Engineering Mathematics, Wiley, 10th Edition, 2011, ISBN: 978-0-470-45836-5.
2	Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, McGraw-Hill Education, 4th Edition, 2018, ISBN: 978-1-260-08325-5.
3	Douglas C. Montgomery, George C. Runger, Applied Statistics and Probability for Engineers, Wiley, 7th Edition, 2018, ISBN: 978-1-119-40215-6.
4	B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 45th Edition, 2024, ISBN: 978-81-933284-9-1.
5	R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House, 5th Edition, 2019, ISBN: 978-81-8487-560-7.

Reference Books	
1	Jake VanderPlas, Python Data Science Handbook, O'Reilly Media, 2nd Edition, 2022, ISBN: 978-1-098-12122-8.
2	Peter V. O'Neil, Advanced Engineering Mathematics, Cengage Learning, 8th Edition, 2017, ISBN: 978-1-305-63515-9.
3	Erwin Kreyszig, Advanced Engineering Mathematics, Wiley, 10th Edition, 2011, ISBN: 978-0-470-45836-5

Web links and Video Lectures (e–Resources)
1. NPTEL: Advanced Engineering Mathematics (IIT Madras) 2. Coursera: Mathematics for Machine Learning (Imperial College) 3. Kaggle: Civil engineering datasets (concrete, geotech)

4. MATLAB/Python tutorials on numerical methods
5. VTU e-learning: Data analytics modules
6. GitHub: Civil data analytics repos]

Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW) Activity**	**Number of Hours / Semester**
1	Matrix eigenvalue assignments (5h); Numerical optimization (5h); Regression projects (5h); Data viz case studies (3h); Mini-project on civil stats (4h); Transform exercises (2h).	24
	OR	
2	Solve matrix applications relevant to structural, thermal, fluid, or transport systems	24
	OR	
3	Prepare a problem set on differential equations from core engineering applications.	24
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL) Activity**	**Number of Hours/ Semester**
1	NPTEL modules on advanced engineering mathematics topics.	24
	OR	
2	Problem-based learning on numerical methods for engineering modelling.	24

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	2	2	1
CO2	3	3	2	2	2	1
CO3	3	3		3	3	1
CO4	3	3	2	3	3	2
CO5	3	3	2	3	3	2

Semester: I						
Sustainable and Climate Resilient Planning and Design						
Course Code	**:**	1MCV102		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50 Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50 Marks
Course Type	**:**	PCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Environmental Engineering, Mathematics, and Building Materials
Knowledge on Fundamental Concepts	Basic knowledge of Environment, Buildings, Urban Planning, and Mathematics
Knowledge on Connected Tools (If any)	Basic knowledge of GIS, Excel, and AutoCAD

Course Learning Objectives: This course will enable the students to	
CLO1	Explain the principles of sustainability, climate change, resilience, and circular economy in the built environment.
CLO2	Analyze climate risks, vulnerabilities, and urban systems using basic GIS and climate data.
CLO3	Apply sustainable site, building, energy, water, and material strategies in planning and design.
CLO4	Evaluate climate-resilient infrastructure and nature-based solutions for sustainable development.
CLO5	Integrate policies, assessment tools, digital technologies, and data-driven methods for sustainable and climate-resilient planning.

Module-1	**No. of Hrs:8 hrs**
Foundations of sustainable planning: Concepts of sustainability, climate change, resilience, vulnerability, adaptation, mitigation, and decarbonization. Principles of sustainable development, SDG linkage, life-cycle thinking, and circular economy in built environments. Introduction to climate-resilient planning for cities, campuses, and infrastructure systems. **Text Book 1:** Ch. 1, 2 **Text Book 2:** Ch. 1, 2, 3 **Text Book 3:** Ch. 1	
Module-2	**No. of Hrs:8 hrs**
Climate risks and urban systems: Climate hazards such as heat waves, intense rainfall, flooding, drought, storm surge, sea-level rise, and landslides. Exposure, sensitivity, and adaptive capacity in urban and rural settings. Risk mapping, vulnerability assessment, basic GIS-based planning concepts, and climate data interpretation for decision-making. **Text Book 1:** Ch. 1, 6 **Text Book 2:** Ch. 3, 5 **Text Book 3:** Ch. 1, 2	
Module-3	**No. of Hrs:9 hrs**
Sustainable site and building strategies: Orientation, passive design, daylighting, natural ventilation, shading, material efficiency, embodied carbon reduction, and water-sensitive design. Green infrastructure, permeable surfaces, rainwater harvesting, heat island mitigation, and demand reduction strategies for energy and water. **Text Book 1:** Ch. 2, 3, 4, 5 **Text Book 2:** Ch. 4, 6, 9, 11 **Text Book 3:** Ch. 10, 14, 17	
Module-4	**No. of Hrs:9 hrs**

Climate-resilient infrastructure and public realm: Resilient Road, drainage, utility, and open-space planning. Flood-resilient design, redundancy, modularity, emergency access, evacuation planning, and safe public spaces. Nature-based solutions, wetlands, urban forests, bioswales, and sponge-city concepts for resilience enhancement. **Text Book 1:** Ch. 5, 6 **Text Book 2:** Ch. 3, 5, 6 **Text Book 3:** Ch. 2, 6, 10, 12, 14, 15, 16	
Module-5	**No. of Hrs:8 hrs**
Policy, assessment, and implementation: Climate policy frameworks, green building rating systems, planning codes, disaster management provisions, and environmental clearance concepts. Sustainability assessment tools, carbon and water footprint basics, monitoring indicators, smart-city integration, digital twins, and data-based planning dashboards. **Text Book 1:** Ch. 7, 8, 9 **Text Book 2:** Ch. 6, 7, 8, 12, 13, 14 **Text Book 3:** Ch. 16, 17	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the principles of sustainable planning, climate resilience, and the built environment.
CO2	Analyze climate risks, hazards, and vulnerabilities affecting settlements, infrastructure, and public spaces.
CO3	Apply planning and design strategies for resource-efficient, low-carbon, and resilient development.
CO4	Evaluate climate-responsive urban and building design measures for thermal comfort, water sensitivity, and disaster risk reduction.
CO5	Integrate policies, standards, nature-based solutions, digital tools, and data-driven methods for sustainable and climate-resilient planning and design.

Text Books	
1	Peter Newman and Isabella Jennings, Cities as Sustainable Ecosystems: Principles and Practices, Island Press, Revised Edition, 2012, ISBN: 978-1-59726-747-2.
2	Peter P. Rogers, Kazi F. Jalal and John A. Boyd, An Introduction to Sustainable Development, Earthscan, Revised Edition, 2012, ISBN: 978-1-84977-047-7
3	Soli J. Arceivala and Shyam R. Asolekar, Wastewater Treatment for Pollution Control and Reuse, Tata McGraw-Hill Education, 3rd Edition, 2006, ISBN: 978-0-07133160-9.
4	R. K. Sapru, Environment Planning and Management in India, Ashish Publishing House, 1st Edition, 1990, ISBN: 978-81-7024-284-0.
5	R. Subramanian, Disaster Management, Vikas Publishing House, 2nd Edition, 2023, ISBN: 978-93-5674-263-5.
6	R. Rajagopalan, Environmental Studies: From Crisis to Cure, Oxford University Press, 3rd Edition, 2016, ISBN: 978-0-19-946646-7.

Reference Books	
1	Intergovernmental Panel on Climate Change (IPCC), *IPCC Assessment Reports*, Cambridge University Press, Latest Assessment Report, 2023, ISBN: 978-1-009-15797-5.
2	National Disaster Management Authority (NDMA), *Guidelines on Disaster Management and Disaster Risk Reduction*, Government of India.
3	Ministry of Housing and Urban Affairs (MoHUA), *National Mission on Sustainable Habitat: Guidelines and Manuals*, Government of India.
4	Central Public Health and Environmental Engineering Organisation (CPHEEO), *Manuals on Water Supply and Treatment, Sewerage and Sewage Treatment, and Storm Water Drainage*, Ministry of Housing and Urban Affairs.
5	Bureau of Indian Standards (BIS), *National Building Code of India 2016*, Bureau of Indian Standards, Latest applicable edition, 2016, ISBN: 978-81-211-0903-0.
6	Bureau of Indian Standards (BIS), *Relevant Indian Standards for Environmental Protection, Sustainable Construction and Urban Infrastructure*, Bureau of Indian Standards.

Web links and Video Lectures (e–Resources)
1. NPTEL and SWAYAM courses on sustainable development, climate change, urban planning, disaster management, and GIS-based planning. 2. Open educational resources on green buildings, resilient infrastructure, and climate-sensitive urban design. 3. Government portals and e-learning modules on urban sustainability, resilience, and planning practice.

Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW) Activity**	**No. of Hrs / Semester**
1	**Activity A – Climate vulnerability case study:** Students analyse a neighborhood, campus, or ward for heat stress, flooding, water scarcity, and propose resilient interventions.	24
	OR	
2	**Activity B – Sustainable design proposal:** Students prepare a concept-level sustainable and climate resilient design for a building/site/public space using passive design, water sensitivity and nature-based solutions	24
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL) Activity**	**No. of Hrs / Semester**
1	NPTEL / MOOC modules on climate change, sustainable planning, and resilient infrastructure.	24
	OR	
2	Preparation of climate risk notes, design checklists, and a digital portfolio of resilient planning strategies.	24

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2				3
CO2	2	3	2	3	1	3
CO3	2	3	3	2	2	3
CO4	2	3	3	2	2	3
CO5	2	3	3	3	3	3

Semester: I						
AI, Machine Learning and Emerging Digital Tools						
Course Code	**:**	1MCV103		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50 Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50 Marks
Course Type	**:**	PCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Basic knowledge of Mathematics, Statistics, and Computer Programming
Knowledge on Fundamental Concepts	Basic understanding of mathematics, statistics, data analysis, and civil engineering concepts
Knowledge on Connected Tools (If any)	Basic knowledge of Python programming or MATLAB (at a beginner level)and data visualization tools is desirable

Course Learning Objectives: This course will enable the students to	
CLO1	Explain the fundamental concepts, types, and applications of AI in civil engineering.
CLO2	Describe supervised learning, regression, neural networks, and deep learning methods.
CLO3	Apply unsupervised learning and machine learning techniques to civil engineering problems.
CLO4	Use AI tools and computer vision techniques for civil engineering applications.
CLO5	Explain robotics, natural language processing, and ethical aspects of AI in civil engineering.

Module – 1	**08 Hrs**

Foundations of AI:

Introduction to Artificial Intelligence, definition, scope and evolution, types of AI, Weak AI including traditional AI, Explainable AI and Generative AI, Strong AI including Artificial General Intelligence, applications of different AI types in civil engineering, intelligent agents and Agentic AI, architecture of AI agents including perception, decision-making and action components, branches of AI including pattern recognition, speech recognition, Natural Language Processing, and AI in optimization including Swarm intelligence and Bio-inspired optimization and their applications in allied domains of civil engineering.

Text Book 1: Ch. 1, 2, 4, 26, 27
Text Book 2: Ch. 1
Text Book 3: Ch. 1, 2

Module – 2	**09 Hrs**

Machine Learning – Supervised Learning Methods:

Introduction to Machine Learning with emphasis on supervised learning, types of supervised learning including regression, linear and polynomial regression for material behaviour analysis, advanced supervised learning paradigms including Transfer Learning and Federated Learning, introduction to Reinforcement Learning in civil engineering control contexts, ANN, Backpropagation, Deep Learning models, model evaluation metrics such as accuracy, precision, recall and F1-score, and diverse applications of supervised learning in allied fields of civil engineering

Text Book 1: Ch. 19, 20, 21, 22
Text Book 2: Ch. 2, 3
Text Book 3: Ch. 3, 4, 5

Module – 3	09 Hrs

ML – Unsupervised Learning and ANN Foundations:

Introduction to unsupervised learning, distinction from supervised learning, clustering techniques including K-means, K-medoids, hierarchical clustering and DBSCAN for spatial and geotechnical data analysis, dimensionality reduction techniques including Principal Component Analysis for data visualization and feature interpretation, introduction to artificial neural networks with focus on biological inspiration and computational models, representational power of a single perceptron, perceptron learning algorithm, limitations of single-layer networks multilayer neural networks and hidden layers, supervised nature of ANN learning, introduction to deep learning architectures including CNN for image-based civil engineering applications and RNN/LSTM for time-series prediction and applications in allied fields of civil engineering.

Text Book 1: Ch. 19, 20, 21
Text Book 2: Ch. 2, 3
Text Book 3: Ch. 4, 5, 6, 9

Module – 4	08Hrs

Computer Vision and AI/ML Implementation Tools:

Introduction to AI-driven digital transformation in civil engineering, ML-based data modelling tools and libraries such as Google Colab, Kaggle, Prophet, statsmodels, SciPy, Matplotlib, and Visual R-Studio, overview of Computer Vision as a major branch of AI, steps of computer vision, CV tools such as OpenCV, Scikit-Image, BoofCV, SimpleCV, Kornia, TensorFlow, PyTorch and YOLO, and applications of computer vision in allied branches of civil engineering.

Text Book 1: Ch. 21, 25, 26
Text Book 2: Ch. 1, 2
Text Book 3: Ch. 5, 6, 7

Module – 5	08 Hrs

Robotics, NLP and Ethical Aspects of AI:

Introduction to robotics as a branch of Artificial Intelligence, classification of robots including industrial, autonomous and collaborative robots, construction robotics including bricklaying robots, 3D printing robots, inspection and monitoring robots, and autonomous construction equipment, predictive maintenance and infrastructure asset management using machine learning, applications of Natural Language Processing in civil engineering, introduction to ethical AI practices, AI governance including frameworks by OECD and UNESCO, and Indian perspective on AI governance including initiatives by NITI Aayog.

Text Book 1: Ch. 2, 23, 25, 27
Text Book 2: Ch. 1
Text Book 3: Ch. 1, 8

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the fundamental concepts, types, evolution, and applications of AI and Machine Learning in civil engineering.
CO2	Analyse AI systems and machine learning models, including supervised learning, unsupervised learning, neural networks, and deep learning.
CO3	Apply suitable AI and Machine Learning methods to structural, geotechnical, transportation, water resource, and sustainability problems.
CO4	Evaluate AI-based digital tools, computer vision, geospatial AI, and data-driven systems for infrastructure monitoring and management.
CO5	Assess advanced AI applications, robotics, ethical issues, governance, and emerging trends for responsible use in civil engineering.

Text Books	
1	Stuart Russell and Peter Norvig,Artificial Intelligence: A Modern Approach, Pearson 4th Edition,2021, ISBN: 978-0-13-461099-3.
2	M. A. Jayaram, Artificial Intelligence and Applications in Core Engineering, PHI Learning, 2026; ISBN: 978-93-5443-935-3.

3	Christopher M. Bishop, Pattern Recognition and Machine Learning,Springer,1st Edition,2006,ISBN: 978-0-387-31073-2.
4	Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 'O'Reilly Media,3rd Edition,2022,ISBN: 978-1-098-12596-7.
5	Kundan Meshram, Machine Learning Applications in Civil Engineering,Elsevier (Woodhead Publishing),1st Edition,2024,ISBN: 978-0-443-15364-8.
6	Vincent C. Müller, Ethics of Artificial Intelligence and Robotics,Oxford University Press / Stanford Encyclopedia of Philosophy,
7	Yoshua Bengio, Aaron Courville, Deep Learning, Ian Goodfellow, MIT Press, I Edition, 2016, ISBN-13: 978-0262035613, ISBN-10: 0262035618
8	Timothy J. Ross, Fuzzy Logic with Engineering Applications, Wiley Publishers, IV Edition, 2016, ISBN-13: 978-1119235866, ISBN-10: 1119235865
9	Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, I Edition, 2010, ISBN-13: 978-1848829343, ISBN-10: 1848829345

Reference Books	
1	Yue Pan and Limao Zhang,Roles of Artificial Intelligence in Construction Engineering and Management: A Critical Review and Future Trends,Elsevier, Automation in Construction,2021,DOI: 10.1016/j.autcon.2020.103517.
2	Limao Zhang, Yue Pan, Xianguo Wu, and Mirosław J. Skibniewski, Artificial Intelligence in Construction Engineering and Management,Springer Singapore,1st Edition,2021,ISBN: 978-981-16-2841-2, ISBN: 978-981-16-2842-9.
3	Margaret A Boden, Artificial Intelligence, II Edition, 1996, Academic Press London, ISBN-13: 978-0121619640, ISBN-10: 0121619646
4	Tom.M. Mitchel, Machine Learning, 2017, Indian Edition, McGraw Hill, ISBN-13: 978-1259096952, ISBN-10: 1259096955
5	Kothari Dwarkadas Pralhaddas, Samui Pijush, Artificial Intelligence in Civil Engineering, 2012, Lambert Academic Publishing, ISBN-13: 978-3659162276, ISBN-10:3659162274
6	Paul Harrison, Artificial Intelligence Applications in Material Science and Engineering,2023, Kindle Edition, ISBN-13: 978-0323950595, ISBN-10: 0323950593

Web links and Video Lectures (e–Resources)	
1	https://www.coursera.org/specializations/machine-learning-introduction?utm_source=chatgpt.com
2	https://colab.research.google.com/
3	https://www.kaggle.com/
4	https://www.tensorflow.org/
5	https://github.com/ipsumium/ML_civil_engineering
6	Web links and Video Lectures (e-Resources):
7	https://www.researchgate.net/publication/383094533_Artificial_Intelligenceand_Applications_in_Civil_Engineering_Module_1
8	https://www.researchgate.net/publication/383669419_AI_and_Applications_in_Civil_E ngineering_Module_2_Machine_Learning
9	https://www.researchgate.net/publication/383951466_AI_for_Civil_Engineers_Module_3_ANNs
10	https://www.researchgate.net/publication/384246445_AI_for_Civil_Engineers_Module_ 4_Dealing_with_Uncertainty
11	https://www.researchgate.net/publication/384429783_AI_and_Applications_in_Civil_Engineering_Module_5_Computer_Vision
12	http://digimat.in/nptel/courses/video/106106213/L01.html

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	**Assignment:** Preparation of Literature Review on latest developments of AI and its applications in Civil Engineering.	24
	OR	
2	**Seminar:** Recent applications of AI, ANN, Fuzzy Logic and Computer Vision in Civil Engineering.	24
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	**NPTEL/MOOC/Online Learning:** Basic concepts and applications of Artificial Intelligence and Machine Learning.	24
	OR	
2	**Online Educational Resources:** Study of AI applications in Civil Engineering through technical videos, tutorials and case studies.	24

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1			1	
CO2	3	3		2	3	
CO3	3	3	3	2	3	2
CO4	2	3	2	3	3	2
CO5	2	2	1	1	2	3

Semester: I						
BUILDING INFORMATION MODELING FOR STRUCTURAL SYSTEMS						
Course Code	:	1MCV104A		**Credits**	:	4
Hours/Week (L: T: P)	:	70(3:0:2)		**CIE**	:	50 Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	:	120(42:0:28:50)		**SEE**	:	50 Marks
Course Type	:	IPCC		**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	Structural Engineering, Building Materials and Construction
Knowledge on Fundamental Concepts	Basic knowledge of structural elements, construction, and engineering drawing
Knowledge on Connected Tools (If any)	Basic knowledge of BIM, AutoCAD, Excel, and openBIM tools

Course Learning Objectives: This course will enable the students to	
CLO1	Explain the principles of BIM and its applications in structural engineering.
CLO2	Apply BIM concepts to set up structural models with required information and quality checks.
CLO3	Develop structural BIM models suitable for coordination and structural analysis.
CLO4	Analyze structural BIM models for coordination, quantities, clashes, and issue management.
CLO5	Prepare structural BIM documentation, reports, and handover information.

Module – 1	**10 Hrs**

Structural Engineering Context and BIM Foundations:

Role of BIM in structural systems: design intent, coordination, construction support, quantities, revision control and handover.

Difference between drawing, 3D geometry, information model, analytical model, fabrication/detailing model and asset record.

Structural systems and model uses: foundations, columns, beams, slabs, walls, bracing, stairs, trusses, frames and secondary structural members.

Model purpose and Level of Information Need: avoid unnecessary over-modelling; model only what supports a decision, check, quantity or deliverable.

OpenBIM foundations: IFC classes for structural elements, property sets, quantity sets, BCF-style issue communication and IDS-style information requirements.

Free/open tool orientation: Bonsai/BlenderBIM, FreeCAD BIM, IfcOpenShell, xBIM/IFC viewers, LibreOffice and open coordination records**.**

Text Book 1: Ch. 1, 2, 3, 5

Text Book 2: Ch. 1, 2, 3, 4

Text Book 3: Ch. 1, 2, 4

Module – 2	**08 Hrs**

Structural Model Setup and Information Requirements:

Project setup: coordinates, grids, levels, storeys/zones, shared origin, naming conventions, file status, revision logic and CDE-style folder structure.

Structural information requirements: element ID, type, material, grade, section size, load-bearing status, fire/corrosion notes where relevant, phase, location and quantity fields.

Classification and object identity: element types, system grouping, foundation zones, work packages, story/level association and asset/record IDs.

IFC inspection: project/site/building/storey hierarchy, IfcColumn, IfcBeam, IfcSlab, IfcFooting, IfcWall, IfcMember and related property/quantity sets.

Quality checks: duplicates, misalignment, wrong levels, missing IDs, missing material/grade, incomplete properties, model origin issues and inconsistent quantities.

Simple information matrices: LOD/LOI/LOIN table, structural model use matrix and exchange-purpose checklist.

Text Book 1: Ch. 2, 3, 5
Text Book 2: Ch. 3, 4
Text Book 3: Ch. 2, 4

Module – 3	08 Hrs

Structural Modelling and Analytical-Readiness:

Model structural elements with fit-for-purpose detail: foundations, columns, beams, slabs, walls, stairs/bracing and steel/concrete member systems.

Analytical-readiness concepts: member axis, connectivity, supports, boundary assumptions, material/section properties, levels, load path and transfer limitations.

Information transfer awareness: what can and cannot be reliably transferred from BIM models to structural analysis/checking workflows.

Prepared simple checks using spreadsheets/OpenSees-style examples or instructor-provided outputs; assessment focuses on interpreting model data and assumptions, not software command mastery.

Reinforcement/detailing awareness: represent only the level needed for quantities, coordination or construction communication unless a dedicated detailing workflow is required.

Model limitations and responsibility: distinguish engineering judgement from model geometry.

Text Book 1: Ch. 2, 5
Text Book 2: Ch. 3, 4, 6
Text Book 3: Ch. 4, 5

Module – 4	08 Hrs

Coordination, Quantities and Issue Management:

Model federation using open files or sample models: structural with architectural, MEP/service, site and infrastructure context.

Coordination checks: openings, shafts, service penetrations, headroom, clearances, support conflicts, foundations/utilities, constructability and temporary works awareness.

Quantity extraction: concrete, steel, formwork zones, member counts, material take-off and reliability checks against model purpose and classification.

Issue management: BCF-style issue log, screenshots, responsible party, severity/risk, decision required, status, due date and closure evidence.

Revision response: update model information, re-export, recheck, record decisions and maintain traceable status.

4D/5D awareness: link model elements to work packages, schedule IDs and quantity/cost records through tables, not mandatory proprietary 4D software.

Text Book 1: Ch. 3, 5, 6
Text Book 2: Ch. 3, 4, 6
Text Book 3: Ch. 1, 4, 5, 6

Module – 5	08 Hrs

Documentation, Handover and Portfolio Delivery:

Structural documentation outputs: plans, sections, schedules, member lists, quantity tables, coordination reports and revision notes.

Open information delivery: IFC export/check, property/quantity review, BCF issue register, model validation note and deliverable index.

Handover and asset-readiness: maintainable structural asset fields where relevant, as-built updates, inspection/maintenance references and record model limitations.

Portfolio compilation: model files, open exchange files, information matrix, issue log, QTO report, validation evidence, drawings/screenshots and decision memo.

Professional review: evaluate whether the model is useful, trustworthy, coordinated and fit for the stated structural BIM use.

Text Book 1: Ch. 4, 5, 6, 8

Text Book 2: Ch. 3, 4, 6

Text Book 3: Ch. 6, 7

PRACTICAL COMPONENT	**(LI- 28 Hrs)**
LIST OF EXPERIMENTS	

Students shall perform practical exercises related to:

1. Define the structural BIM project brief for a small building or infrastructure-support structure, including roles, model uses, exchange purposes, and the LOD/LOI/LOIN matrix.
2. Set up the free/open tool workspace with units, coordinates, levels, grids, zones, naming, status, and a CDE-style folder structure.
3. Inspect a sample IFC structural model to study its hierarchy, classes, property sets, quantity sets, relationships, and missing information.
4. Model the core structural elements using a Bonsai/FreeCAD/open IFC workflow, including foundations, columns, beams, slabs, walls or bracing, and stairs where required.
5. Prepare a structural information register with element IDs, material or grade, section data, level or location, classification, phase, and quantity fields.
6. Prepare an analytical-readiness review table covering connectivity, member axis, support assumptions, properties, load-path notes, and model limitations.
7. Extract and verify quantities for concrete, steel, formwork, and member counts using IFC properties, schedules, or spreadsheet-based quantity checks.
8. Federate or compare the structural model with architectural, service, and site context using open files, and prepare a BCF-style coordination issue log.
9. Update the model and register based on the issues, recheck the outputs, and prepare a revision or decision record.

Compile the final structural BIM portfolio, including the model or open file, IFC inspection report, issue log, quantity report, documentation sheets or screenshots, and handover note.

Course Outcomes: After completing the course, the students will be able to	
CO1	Evaluate the use of BIM in structural design, coordination, construction, and handover.
CO2	Implement structural BIM models using grids, levels, coordinates, elements, and required information.
CO3	Develop structural BIM models of foundations, columns, beams, slabs, walls, bracing, and stairs with required information.
CO4	Analyze structural BIM models for coordination, constructability, clashes, openings, and design issues.
CO5	Develop structural BIM deliverables such as schedules, quantities, IFC/BCF reports, issue logs, and handover documents.

Text Books	
1	Eastman, C., Teicholz, P., Sacks, R. and Liston, K., BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers, John Wiley & Sons, 3rd Edition, 2018, ISBN: 978-1-119-28531-7.
2	Nawari, O. O. and Kuenstle, *M.,* Building Information Modeling: Framework for Structural Design, CRC Press/Routledge, 1st Edition, 2015, ISBN: 978-1-138-01736-1.
3	Hardin, B. and Mc Cool, D., BIM and Construction Management: Proven Tools, Methods, and Workflows, John Wiley & Sons, 2nd Edition, 2015, ISBN: 978-1-118-94031-8.
4	Borrmann, A., König, M., Koch, C. and Beetz, J., Building Information Modeling: Technology Foundations and Industry Practice, *Springer, 1st Edition, 2018, ISBN: 978-3-319-92861-6.*
5	Kumar, B., *A* Practical Guide to Adopting BIM in Construction Projects, Whittles Publishing, 1st Edition, 2020.
6	Baldwin, M., The BIM Manager: A Practical Guide for BIM Project Management – for OpenBIM, Project Information and Coordination, 1st Edition, 2019.

Reference Books	
1	Building SMART International, Open BIM, IFC and Interoperability Documentation, building SMART International.
2	British Standards Institution (BSI), BS 1192:2007 – Collaborative Production of Architectural, Engineering and Construction Information, BSI, 2007+A2:2016, 2016, ISBN: 978-0-580-94791-6.
3	International Organization for Standardization (ISO), ISO 19650 – Organization and Digitization of Information about Buildings and Civil Engineering Works, Including Building Information Modelling – Information Management Using Building Information Modelling, ISO, Latest Edition, 2018–2021, ISBN.
4	Central Public Works Department (CPWD), Introducing BIM in CPWD, Central Public Works Department, Government of India, Latest Edition, Current.
5	Department/Institution, Institutional BIM Guidelines, Execution Planning Documents and Project Scheduling Manuals, Department/Institution, Latest Edition, Current.

Web links and Video Lectures (e–Resources)	
1	NPTEL / SWAYAM modules related to BIM, structural modeling, and digital construction.
2	Building SMART resources on open BIM and IFC.
3	Official software learning portals and tutorials for structural BIM tools.
4	Public BIM case studies from India and abroad for structural coordination and documentation.

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

Sl. No	Term Work (TW)	NO. of Hrs/Sem
1	Structural BIM modeling mini-project: grids, levels, foundations, and framing system.	25
	OR	
2	Structural quantity and schedule portfolio: concrete, reinforcement, and formwork mapping.	25
	OR	
3	Open-book team challenge on structural coordination and review	25

	comments	
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	MOOCs / online certification on BIM and structural modeling.	25
	OR	
2	Tool and software exploration using approved BIM /structural design tools.	25
	OR	
3	Competitive aptitude and concept practice in structural analysis, detailing, and BIM workflows.	25

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2		2	2
CO2	3	3	2		3	2
CO3	3	3	3	2	3	2
CO4	2	3	2	3	3	2
CO5	2	3	3	2	3	2

Semester: I						
BIM FOR CONSTRUCTION SEQUENCING AND RESOURCE MODELING						
Course Code	**:**	1MCV104B		**Credits**	**:**	4
Hours/Week (L: T: P)	**:**	70(3:0:2)		**CIE**	**:**	50 Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	120(42:0:28:50)		**SEE**	**:**	50 Marks
Course Type	**:**	IPCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Engineering Drawing, Construction Materials and Construction Technology
Knowledge on Fundamental Concepts	Basic knowledge of construction, scheduling, project management, quantities, and BIM
Knowledge on Connected Tools (If any)	Basic knowledge of BIM software, Excel, and scheduling tools

Course Learning Objectives: This course will enable the students to	
CLO1	Explain construction planning principles, traditional scheduling methods and BIM-based 3D/4D/5D workflows.
CLO2	Develop BIM-ready model information for construction sequencing, resource planning and progress management.
CLO3	Create 4D BIM sequences by linking model elements with activities, work packages, timelines and construction stages.
CLO4	Analyze resource-loaded schedules, model-based quantities, cost relationships and planned-versus-actual project progress.
CLO5	Develop BIM-enabled site logistics, coordination, issue tracking, safety planning and project delivery outputs.

Module – 1	**10 Hrs**

Fundamentals of Construction Planning and BIM

Construction project lifecycle and contractor-side planning responsibilities.

Difference between planning, scheduling, sequencing, monitoring, and control.

Traditional planning tools: WBS, activity definition, dependencies, milestones, calendars, bar charts, CPM basics, baselines, look-ahead planning, and progress reporting.

Limitations of 2D drawings and bar charts in communicating sequence, workspace, logistics, safety, constructability, and progress.

Introduction to BIM: definition, scope, benefits, history, and evolution.

BIM as a process and information-management method: object-based models, information-rich elements, 3D/4D/5D concepts, CDE basics, interoperability, and open BIM awareness.

Project delivery outputs: model-readiness review, WBS, baseline schedule, model breakdown, 4D sequence, quantity/resource sheet, issue log, site logistics plan, progress report, and final portfolio.

Text Book 1: Ch. 1, 2

Text Book 2: Ch. 1, 2

Text Book 3: Ch. 1, 2

Module – 2	**08 Hrs**

BIM Software Overview and Model Readiness:

BIM software ecosystem: authoring, coordination, scheduling, quantity extraction, and collaboration tools.

BIM-ready planning environments: levels, grids, zones, locations, packages, systems,

trades, and construction stages.

Model quality for 4D/5D: correct categories, object naming, classification, properties, quantities, duplicates, modelling omissions, and planning usability.

Information management basics: revision, status, approval, shared/published information, responsibility matrix, CDE logic, and information updates.

Open BIM awareness: IFC exchange, BCF-style issue communication, model viewing/checking, and basic information validation.

Model breakdown structure and schedule-model mapping rules for construction sequencing, resource planning, and progress updates.

Text Book 1: Ch. 2, 3
Text Book 2: Ch. 2, 4
Text Book 3: Ch. 3, 4

Module – 3	**08 Hrs**

4D BIM and Schedule-Model Integration:

Construction sequence logic for excavation, foundations, substructure, superstructure, enclosure, MEP rough-in, finishes, testing, commissioning, and handover.

Linking building components to activities, work packages, phases, locations, and timelines for 4D simulation.

Task dependencies, construction calendars, baselines, milestones, planned stages, and sequence alternatives within BIM-supported workflows.

4D BIM as a review and communication method for construction methodology, trade interfaces, access, temporary works, workspace conflicts, logistics, and safety review.

Limitations of 4D: model quality dependence, incorrect schedule logic, excessive detail, false precision, and animation without construction reasoning.

Text Book 1: Ch. 6
Text Book 2: Ch. 4, 5
Text Book 3: Ch. 4, 9

Module – 4	**08 Hrs**

5D BIM, Resource Modelling and Project Control:

Traditional resource planning: labour, materials, equipment, crews, productivity, temporary works, workspace, and procurement/package logic.

Quantity take-off and model-assisted quantity review: activity-wise material requirements, cost heads, package-level quantities, and limits of model-based quantities.

Resource-loaded schedules: productivity assumptions, crew/equipment allocation, histograms, smoothing/levelling awareness, and resource constraints.

5D awareness: linking quantities and cost heads to activities for procurement planning, cash-flow support, and package monitoring.

Project controls: planned vs actual progress, status updates, site evidence, delay/variance explanation, corrective action, and dashboard/report preparation.

Text Book 1: Ch. 6
Text Book 2: Ch. 4, 5, 6
Text Book 3: Ch. 4, 6, 9

Module – 5	**08 Hrs**

Site Logistics, Coordination, and Delivery Portfolio:

Site logistics modelling: access routes, storage areas, crane/equipment locations,

temporary facilities, safety barricades, movement paths, and constrained-site planning.

Coordination using linked architectural, structural, and MEP models for execution-stage review and trade interface management.

Issue tracking: issue type, location, severity, responsible party, due date, status, action taken, and closure evidence.

Safety and method planning: hazards, access control, temporary works, sequence-dependent risks, and method-statement support.

Final information delivery: portfolio compilation, CDE folder structure, model/schedule/report deliverables, handover awareness, ethics, data governance, and future directions.

Text Book 1: Ch. 3, 6, 8
Text Book 2: Ch. 5, 6, 7
Text Book 3: Ch. 4, 9, 12

PRACTICAL COMPONENT	**(LI- 28 Hrs)**
LIST OF EXPERIMENTS	

Students shall perform practical exercises related to:

1. Map a BIM-enabled planning workflow and compare it with traditional bar-chart/CPM practice.
2. Inspect a sample building model and prepare a model readiness checklist (levels, grids, zones, categories, naming, properties, quantities, IFC readiness).
3. Develop WBS, activities, dependencies, milestones, calendars and a baseline schedule using a planning tool (spreadsheet, MS Project, Primavera, ProjectLibre or similar).
4. Prepare a model breakdown structure (by level, zone, trade, package, stage) and define mapping rules for schedule-model linking.
5. Link schedule activities to model elements and generate a 4D sequence (excavation to handover).
6. Extract/map quantities and prepare activity-wise resource requirements (materials, labour, equipment, workspace, basic cost heads).
7. Create a site logistics plan (access, storage, temporary facilities, cranes/equipment, safety and movement paths).
8. Review sequencing conflicts and logistics constraints using the model and document them in an issue log.
9. Prepare a planned vs actual progress update with model/status snapshots, site photos/evidence, variance explanations and corrective actions.
10. Compile a final BIM construction planning portfolio (WBS, schedule, model QA, 4D, resource sheet, logistics plan, progress report, issue log, reflection).

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain traditional construction planning and compare it with BIM-based 4D/5D workflows.
CO2	Develop WBS, activity list, dependencies, milestones, calendars, and baseline schedule.
CO3	Prepare BIM-ready model data for sequencing and resource planning.
CO4	Create and analyze 4D construction sequences to identify project issues.
CO5	Develop resource-, progress-, and BIM-linked construction project control outputs

	through a portfolio project.

Text Books	
1	Sacks, R., Eastman, C., Lee, G. and Teicholz, P., BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers, John Wiley & Sons, 3rd Edition, 2018, ISBN: 978-1-119-28753-7.
2	Hardin, B. and McCool, D., BIM and Construction Management: Proven Tools, Methods, and Workflows, John Wiley & Sons, 2nd Edition, 2015, ISBN: 978-1-118-94276-5.
3	Baldwin, A. and Bordoli, D., A Handbook for Construction Planning and Scheduling, John Wiley & Sons, 1st Edition, 2014, ISBN: 978-0-470-67032-3.
4	Kymmell, W., Building Information Modeling: Planning and Managing Construction Projects with 4D CAD and Simulations, McGraw-Hill, 1st Edition, 2008, ISBN: 978-0-07-149453-3.
5	Kumar, B., A Practical Guide to Adopting BIM in Construction Projects, Whittles Publishing, 1st Edition, 2015, ISBN: 978-1-84995-146-3.

Reference Books	
1	Building SMART International, Open BIM, IFC, BCF, IDS and bSDD Documentation, building SMART International, 2026, building SMART identifies IFC, IDS, BCF and bSDD as core open BIM standards and services.
2	British Standards Institution (BSI), ISO 19650 – Information Management Using Building Information Modelling, British Standards Institution, 2018–2021, ISO 19650-1:2018 remains the current edition following its 2024 review.
3	U.S. General Services Administration (GSA), GSA BIM Guide Series and National 3D-4D-BIM Program Documents, U.S. General Services Administration, 2007–Current.
4	GSA BIM Guide Series and National 3D-4D-BIM Program documents.
5	European Federation of Engineering Consultancy Associations (EFCA), BIM and ISO 19650 from a Project Management Perspective, EFCA, Current.

Web links and Video Lectures (e–Resources)	
1	NPTEL/SWAYAM modules on construction planning, project management, BIM and digital construction.
2	Building SMART open BIM learning resources and certification outcomes.
3	Selected software vendor learning portals (only for demonstrations, not as the main academic content).
4	Public BIM case studies (Norway, Singapore, Europe, USA, India) for comparing regulatory submissions, project controls and information management maturity.
5	Institutional datasets: sample models, drawing sets, schedule templates, resource templates, issue
6	NPTEL/SWAYAM modules on construction planning, project management, BIM and digital construction.
7	Building SMART open BIM learning resources and certification outcomes.
8	Selected software vendor learning portals (only for demonstrations, not as the main academic content).
9	Public BIM case studies (Norway, Singapore, Europe, USA, India) for comparing regulatory submissions, project controls and information management maturity.
10	Institutional datasets: sample models, drawing sets, schedule templates, resource templates, issue logs, progress report templates and portfolio templates.

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	Prepare a BIM-enabled construction planning workflow and	25

	compare it with traditional planning methods.	
	OR	
2	Prepare a model readiness checklist covering levels, grids, zones, categories, naming, and properties.	25
	OR	
3	Create a model breakdown structure for 4D sequencing and resource planning.	25
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	Explore open-source BIM tools and their application in model viewing and IFC workflows.	25
	OR	
2	Prepare a short note on BIM-based progress monitoring and project control.	25

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3			2	
CO2	2	3	3		3	
CO3	3	2	3		3	1
CO4	2	3	3	2	3	1
CO5	2	3	3	2	3	2

Semester: I						
REMOTE SENSING AND GIS FOR TRANSPORT MODELING						
Course Code	:	1MCV104C		**Credits**	:	4
Hours/Week (L: T: P)	:	70(3:0:2)		**CIE**	:	50 Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	:	120(42:0:28:50)		**SEE**	:	50 Marks
Course Type	:	IPCC		**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	Engineering Surveying, Transportation Engineering, Mathematics, and Statistics
Knowledge on Fundamental Concepts	Basic knowledge of maps, coordinates, surveying, traffic, statistics, and spatial data
Knowledge on Connected Tools (If any)	Basic knowledge of QGIS/ArcGIS, Google Earth, GPS/GNSS, Excel, and Python

Course Learning Objectives: This course will enable the students to	
CLO1	Explain the fundamentals of remote sensing, GIS, and transport modeling for transport applications.
CLO2	Apply remote sensing data and preprocessing techniques for transport-related spatial analysis.
CLO3	Apply GIS tools for transport data management, network analysis, accessibility mapping, and corridor assessment.
CLO4	Analyze travel patterns, congestion, accessibility, and transport service characteristics using geospatial methods.
CLO5	Evaluate remote sensing and GIS-based transport modeling outputs for planning, traffic management, and infrastructure decisions through a portfolio-based project.

Module – 1	**08 Hrs**

Foundations of remote sensing and GIS for transport systems:

- Concepts of transport planning, traffic analysis, and transport modeling.
- Role of geospatial technologies in transport studies, mobility planning, and infrastructure assessment.
- Overview of remote sensing, GIS, GNSS, mobile mapping, and in-situ traffic sensing.
- **Transport-relevant geospatial data sources**: satellite imagery, aerial photographs, road centerline data, GPS traces, POI datasets, census data, traffic counts, and network data.
- **Transport case examples:** urban road network expansion, congestion hotspots, transit accessibility, accident-prone locations.

Text Book 1: Ch. 13, 14
Text Book 2: Ch. 1, 3, 8, 9
Text Book 3: Ch. 1, 2, 5

Module – 2	**08 Hrs**

Remote sensing for transport data and change detection:

- **Fundamentals of remote sensing:** electromagnetic spectrum, spectral signatures of built-up areas, roads, parking surfaces, open spaces, and land use around corridors.
- **Sensors and platforms for transport applications:** multispectral, high-resolution optical, thermal, and SAR imagery.
- **Image preprocessing:** radiometric and geometric correction, atmospheric correction, mosaicking, image registration for corridor analysis.

- **Image classification and extraction of transport features:** road, built-up, land-use/land-cover classification, impervious surface mapping.
- **Change detection for transport studies:** urban expansion, road corridor growth, encroachment, and land conversion affecting transport demand.

Text Book 1: Ch. 1, 2, 6, 9, 10, 21
Text Book 2: Ch. 3, 4, 5, 6, 7
Text Book 3: Ch. 5, 6, 7, 12

Module – 3	08 Hrs

GIS and spatial analysis for transport modeling:

- **GIS concepts and data models:** raster and vector data, topology, attribute tables, geodatabase design for transport datasets.
- **Spatial data acquisition and management:** digitization, georeferencing, projections, metadata, and quality control.
- **Road network analysis:** connectivity, shortest path, service areas, origin-destination concepts, route choice, and accessibility mapping.
- **Spatial analysis tools:** buffering, overlay, proximity, network analysis, and suitability analysis for transport corridors, terminals, and service areas.
- Terrain and corridor analysis: slope, elevation, curvature, visibility, and constraint mapping for route planning and infrastructure alignment.

Text Book 1: Ch. 15, 16, 17, 18
Text Book 2: Ch. 9, 10, 11, 12, 14, 15
Text Book 3: Ch. 3, 4, 5, 11, 12, 13, 17

Module – 4	08 Hrs

Transport modeling with geospatial inputs:

- **Role of models in transport engineering:** trip generation, trip distribution, mode choice, assignment, and simulation.
- **Travel demand inputs from GIS:** land use, population, employment, activity centers, and network characteristics.
- **Congestion and accessibility modeling:** travel time surfaces, impedance, service coverage, and equity indicators.
- **Public transport and paratransit modeling:** stop spacing, catchment analysis, feeder service planning, and accessibility to transit.
- **Uncertainty in transport geospatial models:** data gaps, scale effects, temporal variation, model assumptions, and reliability communication.

Text Book 1: Ch. 18, 19, 20, 21
Text Book 2: Ch. 14, 15, 16, 20, 21
Text Book 3: Ch. 11, 12, 15, 17, 18

Module – 5	08 Hrs

Advanced tools, cloud platforms, and transport case studies:

- **Open-source and commercial platforms for transport GIS:** QGIS, GRASS, ArcGIS Pro, ArcGIS Network Analyst, and transport extensions.
- **GPS and GNSS-based mobility data:** floating car data, mobile mapping, trajectory analysis, and traffic monitoring.
- Cloud-based geospatial workflows for large-area transport analysis and time-series mobility studies.

- **Basic machine learning for transport prediction:** traffic volume estimation, congestion classification, accident hotspot prediction, and accessibility modeling.
- **Case studies in transport modeling:** urban road network planning, transit accessibility, freight movement, corridor development, and smart mobility.
- **Ethics, governance, and sustainability:** privacy in mobility data, open transport data, and responsible use of geospatial information.

Text Book 1: Ch. 7, 11, 18, 20, 21
Text Book 2: Ch. 8, 14, 15, 16, 20, 21
Text Book 3: Ch. 1, 11, 12, 17, 18

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the concepts of remote sensing, GIS, and transport modeling workflows.
CO2	Apply geospatial data, transport data, and field observations for transport system analysis.
CO3	Apply GIS tools for mapping, preprocessing, network preparation, and spatial analysis of transport variables.
CO4	Analyze travel patterns, accessibility, congestion, and transport service characteristics using geospatial methods.
CO5	Evaluate remote sensing and GIS-based transport modeling outputs for planning, traffic management, and infrastructure decisions through a portfolio-based project.

Text Books	
1	Basudeb Bhatta, Remote Sensing and GIS, Oxford University Press, 3rd Edition, 2020, ISBN: 9780199496648.
2	M. Anji Reddy, *Textbook of* Remote Sensing and Geographical Information Systems, BS Publications, 5th Edition, 2024, ISBN: 9788197765698.
3	Kang-Tsung Chang, Introduction to Geographic Information Systems, McGraw-Hill Education, 9th Edition, 2019, ISBN: 9781259929649.
4	Thomas M. Lillesand, Ralph W. Kiefer and Jonathan W. Chipman, Remote Sensing and Image Interpretation, Wiley, 7th Edition, 2015, ISBN: 9781118343289.
5	Basudeb Bhatta, Remote Sensing and GIS, Oxford University Press, 3rd Edition, 2020, ISBN: 9780199496648.

Reference Books	
1	Chor Pang Lo and Albert K. W. Yeung, *Concepts and* Techniques of Geographic Information Systems, Prentice Hall, 2nd Edition, 2007, ISBN: 9780131495029.
2	John R. Jensen, Remote Sensing of the Environment: An Earth Resource Perspective, Pearson Prentice Hall, 2nd Edition, 2007, ISBN: 9780131889507.
4	Peter A. Burrough, Rachael A. McDonnell and Christopher D. Lloyd, Principles of Geographical Information Systems, Oxford University Press, 3rd Edition, 2015, ISBN: 9780198742845.
5	Michael N. DeMers, Fundamentals of Geographic Information Systems, John Wiley & Sons, 4th Edition, 2008, ISBN: 9780470129067.

Web links and Video Lectures (e – Resources)	
1	NPTEL/SWAYAM preview: Remote Sensing and GIS.
2	Google Earth Engine introductory learning resources.
3	NASA ARSET training materials on geospatial analysis.
4	QGIS and OpenStreetMap learning resources.
5	Transport GIS and mobility analytics tutorials

	PRACTICAL COMPONENT	(LI- 28 Hrs)
1	Prepare georeferenced base maps of a transport study area using GIS software.	
2	Import and preprocess satellite or UAV-derived transport and land-use data.	
3	Generate road network and land-use maps from sample imagery.	
4	Perform buffer and overlay analysis for transport corridors and service zones.	
5	Create terrain-derived layers such as slope, aspect, and elevation zones for route planning.	
6	Carry out accessibility or proximity analysis for transport facilities.	
7	Prepare a congestion hotspot or accident hotspot map.	
8	Develop a simple transport suitability or corridor analysis map.	
9	Integrate field survey or GPS observations with GIS layers.	
10	Compile a transport GIS portfolio.	

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	**Transport base map preparation:** Prepare a georeferenced base map of an urban or regional transport study area showing roads, junctions, transit stops, land use, and important landmarks. Include coordinate system, scale, legend, north arrow, and source details.	25
	OR	
2	**Transport corridor mapping** Use GIS to digitize a road corridor or transit route and prepare layers for carriageway, intersections, bus stops, railway stations, and activity centers. Add a short note on corridor characteristics and connectivity.	25
	OR	
3	**Route suitability analysis** Prepare a simple suitability map for a proposed road or transit alignment using factors such as slope, land use, built-up area, water bodies, and constraints. Assign weights and explain the selection logic	25
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	**QGIS / ArcGIS self-study** Learn layer management, symbology, georeferencing, digitization, buffer analysis, and map composition using a sample transport dataset.	25
	OR	
2	**Google Earth Engine basics** Explore how time-series imagery can support corridor growth analysis, built-up mapping, or transport-related land-use studies.	25
	OR	
3	**Case study review** Prepare a one-page review of a published transport GIS case study, such as congestion mapping, transit accessibility, or road	25

	expansion analysis.	

CO – PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	2	1	1
CO2	2	2	1	3	3	2
CO3	2	3	2	2	3	2
CO4	2	3	2	3	3	3
CO5	2	3	3	3	3	3

Semester: I						
GEO BIM FOR GEOTECHNICAL MODELING AND UNDERGROUND INFRASTRUCTURE						
Course Code	**:**	1MCV104D		**Credits**	**:**	04
Hours/Week (L: T: P)	**:**	70(3:0:2)		**CIE**	**:**	50 Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	120(42:0:28:50)		**SEE**	**:**	50 Marks
Course Type	**:**	IPCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Engineering Geology, Geotechnical Engineering, Engineering Surveying, Building Information Modelling
Knowledge on Fundamental Concepts	Basic knowledge of soil and rock properties, foundations, slopes, groundwater, surveying, GIS and BIM concepts
Knowledge on Connected Tools (If any)	Basic knowledge of QGIS, AutoCAD/BIM software, spreadsheets, GPS/GNSS and digital mapping tools

Course Learning Objectives: This course will enable the students to	
CLO1	Explain the fundamentals of geotechnical engineering, GIS, BIM and GeoBIM.
CLO2	Prepare structured ground investigation data and digital ground models.
CLO3	Develop GIS-based terrain, geohazard and underground infrastructure maps.
CLO4	Interpret geotechnical risks using GIS and analysis outputs.
CLO5	Evaluate BIM/GeoBIM workflows for underground assets, monitoring and safety.

Module – 1	**10 Hrs**

Geotechnical Engineering, GIS, BIM and GeoBIM Foundations:

- What geotechnical engineers do: interpreting soil, rock and groundwater as uncertain engineering information for design and construction decisions.
- Geotechnical lifecycle: desk study, site reconnaissance, ground investigation planning, factual records, interpretive ground model, analysis/design, construction observation, monitoring and lifecycle records.
- Three-pillar digital context: GIS for terrain/geology/hazards/corridors; BIM for designed/constructed assets; GeoBIM as the practical link between geospatial context, ground data and project information.
- Project setup fundamentals: CRS/datum, coordinates, units, chainage, levels, file naming, data ownership, CDE-style folders and limitations of forcing ground data into ordinary BIM object categories.
- Industry workflow: ground problem → required information → structured data → GIS/sections → geotechnical interpretation → coordination → decision output.
- Free/open tool orientation: QGIS, PostGIS, GeoServer, QField/Mergin Maps, LibreOffice, HYRCAN, CloudCompare, Bonsai/IfcOpenShell and simple dashboard tools.

Text Book 1: Ch. 1, 2, 3, 4
Text Book 2: Ch. 1, 2, 3, 4
Text Book 3: Ch. 1, 2, 3

Module – 2	**08 Hrs**

Ground Investigation Data, Subsurface Interpretation and Digital Ground Models:

- Ground investigation inputs: boreholes, trial pits, SPT/CPT, sampling, laboratory tests, RQD/core logs, groundwater readings, geophysics, field observations and monitoring points.
- Difference between factual data and interpretive judgement; recording assumptions and uncertainty instead of presenting ground models as absolute truth.

- Structured ground data template: borehole ID, coordinates, surface level, depth intervals, strata description, classification, samples/tests, groundwater dates, utilities, remarks and quality flags.
- Subsurface interpretation outputs: borehole logs, ground sections, strata tables, groundwater notes, foundation/excavation zones and simple quantity fields.
- Designed assets for coordination: piles, pile caps, basements, retaining walls, excavation support, utilities, drainage and ground-improvement zones as coordinate-controlled objects.
- Spreadsheet-to-map/model awareness: students are assessed on data correctness, interpretation and coordination logic, not scripting mastery.

Text Book 1: Ch. 5, 6, 7, 8, 9
Text Book 2: Ch. 5, 6, 7, 8, 9
Text Book 3: Ch. 4, 5, 6

Module – 3	08 Hrs

GIS-Based Geohazard, Terrain and Corridor Risk Mapping:

- Application areas: hill roads, cut slopes, embankments, landslides, rock slopes, rockfall zones, tunnel portals, foundations near slopes, retaining systems and drainage-sensitive corridors.
- QGIS workflows: DEM/DTM, contours, slope angle, aspect, drainage, land cover, geology, rainfall, historical landslide inventory, seismic/geohazard overlays, utilities, boreholes and monitoring points.
- Geotechnical interpretation: factor of safety concept, rainfall and pore-pressure influence, drainage, erosion, seepage paths, ground movement indicators, exposure and mitigation options.
- Rock and earthquake awareness: discontinuities, bedding, weathering, RQD, planar/wedge/toppling failure, rockfall exposure, seismic slope risk and liquefaction screening where relevant.
- Industry outputs: geohazard map, slope/rockfall inventory, mitigation-priority table, corridor risk zoning, screening sheet and decision note explaining required next investigation/design review.

Text Book 1: Ch. 11, 12, 13, 14
Text Book 2: Ch. 10, 11, 12, 13
Text Book 3: Ch. 7, 8, 9

Module – 4	08 Hrs

Underground Assets, Analysis Outputs and GeoBIM Coordination:

- Underground infrastructure workflow: alignment/corridor study; ground model by chainage; tunnel portals; shafts; cross passages; utilities; basements; retaining systems; drainage; settlement-sensitive zones.
- Analysis awareness: bearing/settlement screening; earth pressure; seepage; slope stability; excavation deformation; tunnel settlement; soil–structure interaction; construction-stage behaviour; seismic/geotechnical risk screening using prepared open-source/simplified outputs.
- Interpreting analysis outputs: factor of safety, deformation contours, pore-pressure plots, settlement profiles, support class notes and sensitivity checks.
- Executable analysis exposure: spreadsheet checks, HYRCAN-style slope checks, OpenSees awareness for soil–structure interaction and instructor-prepared datasets.

- GeoBIM coordination outputs: linking GIS risk maps, structured ground data, interpretation and BIM/IFC/model-viewer information for underground assets, quantities, construction stages and issue tracking

Text Book 1: Ch. 15, 16, 17
Text Book 2: Ch. 14, 15, 16
Text Book 3: Ch. 10, 11, 12

Module – 5	**08 Hrs**

Monitoring, Digital Twin Awareness and Lifecycle Decision Support:

- Construction and lifecycle monitoring: settlement markers, inclinometers, piezometers, crack meters, tilt sensors, vibration, rainfall gauges, tunnel convergence, visual inspections and progress/condition records.
- Human-centric safety logic: green/amber/red trigger levels, responsible action, escalation route, site inspection, design review, closure/mitigation and observational method awareness.
- Dashboard and decision outputs: LibreOffice/Metabase/Grafana-style monitoring dashboard, QGIS monitoring map, risk register, issue log, mitigation tracker, progress report and decision memo.
- Digital twin awareness: monitored physical ground/asset system + digital representation + sensor/inspection data + analysis/risk logic + action workflow, not merely a 3D model.

Lifecycle portfolio: data register, GIS maps, sections, risk register, issue log, monitoring dashboard, handover note and reflection on uncertainty/limitations.
Text Book 1: Ch. 18, 19, 20
Text Book 2: Ch. 17, 18, 19
Text Book 3: Ch. 13, 14

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the fundamentals of geotechnical engineering, GIS, BIM and GeoBIM.
CO2	Prepare structured ground investigation data registers.
CO3	Develop QGIS-based maps for terrain, hazards, utilities and underground infrastructure.
CO4	Interpret geotechnical risks using GIS outputs and analysis results.
CO5	Evaluate BIM/GeoBIM coordination and digital geotechnical workflows for underground assets, construction activities, monitoring, and safety.

Text Books	
1	Braja M. Das and Khaled Sobhan, Principles of Geotechnical Engineering, Cengage Learning, 9th Edition, 2018, ISBN: 9781305970939**.**
2	Donald P. Coduto, Man-chu Ronald Yeung and William A. Kitch**,** Geotechnical Engineering: Principles and Practices, Pearson, 2nd Edition, 2011, ISBN: 9780132368682**.**
3	J. Michael Duncan, Stephen G. Wright and Thomas L. Brandon**,** Soil Strength and Slope Stability, John Wiley & Sons, 2nd Edition, 2014, ISBN**:** 9781118651650.
4	Duncan C. Wyllie and Christopher W. Mah**,** Rock Slope Engineering: Civil Applications, CRC Press, 5th Edition, 2017, ISBN: 9781498786270**.**
5	John Dunnicliff, Geotechnical Instrumentation for Monitoring Field Performance, John Wiley & Sons, 2nd Edition, 1993, ISBN**:** 9780471005461**.**
6	Braja M. Das and Khaled Sobhan**,** *Principles of Geotechnical Engineering*, Cengage Learning, 9th Edition, 2018, ISBN: 9781305970939**.**

Reference Books

1	Charles Eastman, Paul Teicholz, Rafael Sacks and Kathleen Liston, BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers, John Wiley & Sons, 3rd Edition, 2018, ISBN: 9781119287537.
2	André Borrmann, Markus König, Christian Koch and Jakob Beetz, Building Information Modeling: Technology, Methods and Applications, Springer, 2018, ISBN: 9783319161742.
3	Bansal, GIS and BIM in Infrastructure Projects: An Introduction to Applications Across the Lifecycle, Routledge.
4	Lawrence K. W. Shum, Evolution of Three-Dimensional Geotechnical Information Infrastructure, AIJR Books.
5	UNECE/TEM Working Group, Building Information Modelling (BIM) for Road Infrastructure: TEM Requirements and Recommendations, UNECE.
6	ISO, ISO 19650-1:2018 – Organization and Digitization of Information about Buildings and Civil Engineering Works, Including BIM – Information Management Using BIM, International Organization for Standardization, 2018.
7	Building SMART International, open BIM and IFC Guidance Documents, building SMART International.
8	Central Public Works Department (CPWD), CPWD BIM / Works Manuals and Publication Guidance, Government of India.
9	Charles Eastman, Paul Teicholz, Rafael Sacks and Kathleen Liston, BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers, John Wiley & Sons, 3rd Edition, 2018, ISBN: 9781119287537.
10	André Borrmann, Markus König, Christian Koch and Jakob Beetz, Building Information Modeling: Technology, Methods and Applications, Springer, 2018, ISBN: 9783319161742.

Web links and Video Lectures (e – Resources)	
1	QGIS Training Manual, Post GIS documentation, GRASS/SAGA GIS resources, HYRCAN documentation and open geospatial data resources – GIS and geohazard workflows.
2	Building SMART International documentation on IFC, BCF, IDS and bSDD – coordination and information exchange awareness for Geo BIM/open BIM.
3	Selected papers/case studies on Geo BIM, tunnel ground modelling, FAIR geotechnical data, BIM–GIS integration and geotechnical digital twins – advanced awareness topics building SMART International – open BIM Official resources on IFC, interoperability, and open BIM workflows. Useful for standards-based Geo-BIM learning. Link: building SMART open BIM
4	ISO 19650 guidance – BSI / ISO resources Reference material on information management using BIM, suitable for project data organization and collaboration. Link: ISO 19650 resources
5	CPWD Publication / BIM guidance. Government guidance and publications useful for Indian infrastructure and public works context.

	PRACTICAL COMPONENT	**(LI- 28 Hrs)**
1	Project brief and data inventory: define one controlled teaching project site and list stakeholders, ground risks, available data and required decisions.	
2	Structured ground data register: enter borehole, strata, groundwater, test, utility, foundation/excavation and monitoring fields into a spreadsheet template with IDs, coordinates, units and quality flags.	
3	QGIS base map: map site boundary/corridor, borehole points, contours/DEM, drainage, utilities, proposed underground assets and constraints.	
4	Ground interpretation outputs: prepare borehole logs, simple ground sections, groundwater notes and foundation/excavation zones from structured data; state assumptions and uncertainty.	
5	Geohazard screening: prepare DEM-derived slope/drainage maps, landslide/rockfall inventory and mitigation-priority table.	

6	Underground asset coordination: prepare a coordination sheet or model-viewer issue log showing piles, retaining systems, tunnel/shaft/utility zones, groundwater or settlement-sensitive areas and quantity fields.
7	Analysis-output interpretation: interpret one provided output such as slope factor of safety, seepage/pore-pressure plot, excavation deformation, settlement profile or tunnel support-risk output.
8	Chainage or zone risk register: link geology/groundwater, utilities, geohazards, settlement-sensitive locations, construction stages and responsible actions.
9	Monitoring dashboard: prepare a table/dashboard for piezometer, inclinometer, settlement/rainfall or tunnel-convergence readings with trigger levels and response actions.
10	Final portfolio and decision memo: compile GIS maps, structured data, sections, analysis interpretation, issue log, monitoring dashboard and recommendation memo.

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	Underground utility mapping and clash analysis case study	25
	OR	
2	Geotechnical and structural coordination mini-project for a basement, tunnel, or retaining system.	25
	OR	
3	Concept practice in soil behavior, ground investigation, and underground construction workflows.	25
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	Geo-BIM literature review and summary report on underground infrastructure applications.	25
	OR	
2	Tool and software exploration using approved Geo-BIM and geotechnical design tools.	25

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	1	2	1	1
CO2	2	2	1	3	3	1
CO3	2	3	2	3	3	2
CO4	3	3	2	3	2	3
CO5	2	3	3	3	3	3

Semester: I						
GEOSPATIAL ENVIRONMENTAL MONITORING AND MODELING						
Course Code	**:**	**1MCV104E**		**Credits**	**:**	04
Hours/Week (L: T: P)	**:**	70(3:0:2)		**CIE**	**:**	50 Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	120(42:0:28:50)		**SEE**	**:**	50 Marks
Course Type	**:**	IPCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Engineering Surveying, Environmental Engineering, Mathematics, Remote Sensing and GIS.
Knowledge on Fundamental Concepts	Basic knowledge of environment, maps, surveying, statistics, remote sensing, GIS, and spatial data.
Knowledge on Connected Tools (If any)	Basic knowledge of QGIS/ArcGIS, Google Earth Engine, GPS/GNSS, and Excel.

Course Learning Objectives: This course will enable the students to	
CLO1	Explain the fundamentals of geospatial technologies for environmental monitoring and modelling.
CLO2	Apply remote sensing techniques for environmental data processing and change detection.
CLO3	Develop GIS-based spatial analyses for environmental assessment and mapping.
CLO4	Analyze environmental patterns using geospatial modelling techniques.
CLO5	Evaluate geospatial monitoring outputs for environmental planning and decision-making.

Module – 1	**8 Hrs**

Geospatial foundations for environmental monitoring:

- Concepts of environmental monitoring and modelling; environmental indicators, spatial and temporal scales of observation.
- Overview of geospatial technologies: remote sensing (RS), geographic information systems (GIS), global navigation satellite systems (GNSS), in-situ sensor networks for environmental applications.
- Geospatial data sources and characteristics: maps, aerial photographs, satellite imagery, DEM/DSM, crowdsourced and sensor data; spatial and attribute data structures.
- Environmental case examples: land-use/land-cover (LULC) dynamics, watershed condition, urban heat islands, pollution hotspots.

Text Book 1: Ch. 1, 2, 3
Text Book 2: Ch. 1, 2, 3
Text Book 3: Ch. 1, 2, 3

Module – 2	**08 Hrs**

Remote sensing for environmental variables and change:

- Fundamentals of remote sensing: electromagnetic spectrum, interaction of EMR with atmosphere and earth surfaces (water, vegetation, soil, built-up); spectral signatures of key environmental features.
- Sensors and platforms for environmental monitoring: multispectral, hyperspectral, thermal and microwave sensors; spatial, spectral, radiometric and temporal resolutions; environmental satellite missions (illustrative examples).
- Image preprocessing: radiometric and geometric correction, atmospheric correction, image registration and mosaicking for environmental time-series

analysis.

- Environmental indices and products: vegetation and drought indices (e.g., NDVI family), water and moisture indices (e.g., NDWI-type), urban/built-up indices for sprawl and heat-island assessment.
- Image classification and change detection: supervised and unsupervised classification concepts, accuracy assessment, post-classification change detection,multi-temporal analysis for land-use/land-cover and ecosystem change.

Text Book 1: Ch. 4, 5, 6
Text Book 2: Ch. 2, 7, 8, 11, 12, 13, 14
Text Book 3: Ch. 6, 7, 8, 9, 10, 11

Module – 3	**08 Hrs**

GIS and spatial analysis for environmental applications:

- GIS concepts and data models: raster and vector data, topology, attribute tables; geodatabase design for environmental datasets.
- Spatial data acquisition and management: digitization, georeferencing, projections, metadata, data quality and error sources in environmental GIS.
- Spatial analysis tools: map algebra, overlay operations, buffering, proximity and network analysis for environmental site selection, hazard and service-coverage studies.
- Terrain and watershed analysis: DEM/DTM generation, slope, aspect and curvature, watershed and stream network delineation, basic erosion/susceptibility mapping in GIS.
- Introduction to spatial multi-criteria analysis (SMCA) for environmental suitability and vulnerability mapping.

Text Book 1: Ch. 3, 4, 5, 6, 7, 8
Text Book 2: Ch. 5, 6, 14
Text Book 3: Ch. 3, 4, 5, 11, 12, 13

Module – 4	**08 Hrs**

Environmental modelling with geospatial inputs:

- Role of models in environmental engineering: types of models (empirical, conceptual, physically based), model structure, calibration, validation and sensitivity analysis.
- Watershed and hydrological modelling: rainfall–runoff, infiltration, surface and groundwater interactions; use of RS/GIS data for parameterization and scenario analysis.
- Water-quality and pollution modelling: point and non-point source pollution, basic transport and fate concepts; integration of land-use, hydro-meteorological and monitoring data in GIS environments.
- Land-use/land-cover and habitat models: habitat suitability, environmental flow support, biodiversity and ecosystem-service-related models using geospatial layers.
- Uncertainty in geospatial environmental models: data gaps, resolution and scale effects, model assumptions; communication of reliability to decision-makers.

Text Book 1: Ch. 9, 10, 11, 12
Text Book 2: Ch. 11, 12, 13, 14
Text Book 3: Ch. 14, 15, 16, 17, 18

Module – 5	**08 Hrs**

Advanced tools, cloud platforms and case studies:

- Open-source and commercial platforms for geospatial environmental analysis: QGIS/GRASS, ArcGIS Pro/ArcGIS Online, and specialized environmental extensions (overview).
- Cloud-based geospatial platforms: concepts of cloud computing for big geospatial data; introduction to Google Earth Engine style workflows for large-area environmental monitoring and time-series analysis.
- Basic machine learning for environmental predictions: examples of regression/classification for streamflow, evapotranspiration, land-cover change or pollution forecasting using geospatial inputs.
- Case studies in geospatial environmental monitoring and modelling: urban expansion and air-quality; flood and drought risk mapping; soil erosion and landslide susceptibility; climate vulnerability and ecosystem change.
- Ethics, governance and sustainability: data privacy, citizen science, open data policies; responsible use of geospatial technologies for environmental decision-making.

Text Book 1: Ch. 13, 14, 15
Text Book 2: Ch. 10, 11, 12, 13, 14
Text Book 3: Ch. 17, 18

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the concepts of geospatial data, environmental monitoring, and modeling workflows.
CO2	Apply GIS, remote sensing, and field data integration for environmental assessment.
CO3	Apply geospatial tools for mapping, preprocessing, and spatial analysis of environmental variables.
CO4	Analyze temporal and spatial environmental patterns using geospatial models.
CO5	Analyze monitoring outputs to support environmental planning and decision-making.
CO6	Evaluate a geospatial environmental monitoring and modeling workflow through a portfolio-based project.

Text Books	
1	Peter A. Burrough, Rachael A. McDonnell and Christopher D. Lloyd, Principles of Geographical Information Systems, Oxford University Press, 3rd Edition, 2015, ISBN: 9780198742845. VitalSource
2	John R. Jensen, Remote Sensing of the Environment: An Earth Resource Perspective, Pearson, 2nd Edition, 2007, ISBN: 9780131889507. Pearson
3	Kang-tsung Chang, Introduction to Geographic Information Systems, McGraw-Hill Education, 9th Edition, 2019, ISBN: 9781259929649. McGraw Hill Education
4	James B. Campbell and Randolph H. Wynne, Introduction to Remote Sensing, Guilford Press, 5th Edition, 2011, ISBN: 9781609181772.

Reference Books	
1	Paul A. Longley, Michael F. Goodchild, David J. Maguire and David W. Rhind, Geographic Information Systems and Science, John Wiley & Sons, 4th Edition, 2015, ISBN: 9781118676950. World Cat.
2	Thomas M. Lillesand, Ralph W. Kiefer and Jonathan W. Chipman, Remote Sensing and Image Interpretation, John Wiley & Sons, 7th Edition, 2015, ISBN: 9781118343289. Wiley-VCH
3	Open-source GIS documentation and environmental modelling manuals, QGIS, GRASS GIS and related official documentation.

4	Government and agency technical manuals on environmental monitoring and spatial analysis, including relevant environmental monitoring and geospatial-analysis guidelines.

Web links and Video Lectures (e – Resources)	
1	NPTEL: Remote Sensing and GIS — a full lecture series covering remote sensing basics, image correction, image classification, GIS, and applications of remote sensing and GIS.
2	NPTEL/SWAYAM preview: Remote Sensing and GIS — useful as a course entry point and for structured lecture access.
3	NASA ARSET: Using Google Earth Engine for Land Monitoring Applications — training material on change detection, time-series analysis, land cover classification, and accuracy assessment.
4	Google Earth Engine introductory video — practical demonstration of using GEE for environmental monitoring, including Sentinel-2 selection, composites, and NDVI.
5	Google Earth Engine lab tutorial series — useful for hands-on environmental monitoring workflows and coding practice.
6	GeoField Resources — curated learning opportunities and practical toolkits for remote sensing, Google Earth Engine, and spatial analytics**.**

	PRACTICAL COMPONENT	**(LI- 28 Hrs)**
1	Prepare georeferenced base maps using GIS software.	
2	Import and preprocess satellite or UAV-derived environmental data.	
3	Generate land use/land cover maps from sample imagery.	
4	Perform buffer and overlay analysis for an environmental study area.	
5	Create terrain-derived layers such as slope, aspect, and elevation zones.	
6	Carry out spatial interpolation for sampled environmental parameters.	
7	Prepare a change-detection analysis using multi-date data.	
8	Develop a pollution or hazard susceptibility map.	
9	Integrate field survey observations with GIS layers.	
10	Compile a geospatial environmental monitoring portfolio.	

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	**Perform spatial analysis for an environmental issue.** Example tasks include buffer analysis around water bodies, overlay analysis for pollution zones, or proximity analysis for sensitive receptors	25
	OR	
2	**Create terrain and drainage interpretation layers.** Students derive slope, aspect, elevation zones, and drainage influence maps to support watershed or hazard analysis	25
	OR	
3	**Develop a change-detection study using multi-date imagery.** Students compare two time periods to identify urban expansion, deforestation, wetland loss, or land degradation.	25
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	**Explore an open-source GIS workflow.**	25

	Learn QGIS basics, load sample environmental layers, and prepare a short note on menu functions, map composition, and spatial analysis tools	
	OR	
2	**Study Google Earth Engine fundamentals.** Watch an introductory tutorial, create a simple script, and document one environmental monitoring example such as NDVI or land cover change.	25
	OR	
3	**Complete a mini case study.** Choose one topic such as flood risk, urban heat island, deforestation, or watershed monitoring, and prepare a short self-study report using publicly available data	25

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	1	2	1	2
CO2	2	2	1	3	3	2
CO3	2	3	2	3	3	2
CO4	2	3	2	3	3	3
CO5	2	3	3	3	3	3

Semester: I						
BIM AND HYDRO-GIS MODELING FOR RIVER BASIN SYSTEMS						
Course Code	**:**	**1MCV104F**		**Credits**	**:**	04
Hours/Week (L: T: P)	**:**	70(3:0:2)		**CIE**	**:**	50 Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	120(42:0:28:50)		**SEE**	**:**	50 Marks
Course Type	**:**	IPCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Engineering Surveying, Hydrology, GIS and BIM
Knowledge on Fundamental Concepts	Basic surveying, maps, GIS, hydrology, river basins and BIM concepts
Knowledge on Connected Tools (If any)	QGIS/ArcGIS, AutoCAD/Civil 3D, MS Excel, GPS/GNSS

Course Learning Objectives: This course will enable the students to	
CLO1	Explain the fundamentals of BIM, GIS, Hydro-GIS, Geo BIM and river basin information workflows.
CLO2	Apply georeferencing, spatial data preparation and terrain modelling techniques for river basin projects.
CLO3	Develop basic BIM-Hydro-GIS information models for river basin infrastructure assets.
CLO4	Analyze integrated BIM-GIS models for spatial conflicts, flood exposure, drainage issues and information-quality problems.
CLO5	Evaluate integrated Hydro-GIS/VDC workflows for river basin planning, coordination and asset management.

Module – 1	**10 Hrs**

Fundamentals of BIM, Hydro-GIS and River Basin Systems:

- Introduction to BIM, GIS, Hydro-GIS, Geo BIM and VDC: definitions, scope, applications, and limitations in river basin projects.
- Overview of river basin systems: rivers, tributaries, canals, embankments, barrages, dams, spillways, sluices, regulators, culverts, drains, detention structures, pump stations, and riverfront work.
- BIM as a digital asset and project information model; GIS as a spatial context and analysis framework.
- Difference between surveying, CAD drafting, GIS mapping, civil modelling, BIM/VDC coordination, and hydrologic/hydraulic simulation models.
- Role of BIM-GIS integration in basin planning, design coordination, construction documentation, flood management, site review, asset handover, and lifecycle information management.

Text Book 1: Ch. 1, 2, 3
Text Book 2: Ch. 1, 2, 3
Text Book 3: Ch. 1, 2

Module – 2	**08 Hrs**

Spatial Data, Georeferencing and Information Setup:

- Coordinate reference systems, georeferencing, model origin, map projections, levels, units, scale, and accuracy management.
- Spatial data types: raster, vector, DEM, contours, drainage layers, land use, soil, survey data, floodplain layers, river network layers, and asset-location data.
- BIM/civil asset information basics: elements, objects, attributes, parameters, classification, metadata, asset IDs, status, and revision information.

- Data preparation and cleaning for terrain, basin assets, drainage context, and project information exchange.
  Interoperability basics: IFC for built/infrastructure assets where applicable, LandXML for civil/terrain data, GeoPackage/GeoTIFF/CSV for GIS data, and BCF or structured issue logs for coordination.

Text Book 1: Ch. 4, 5, 6
Text Book 2: Ch. 4, 5, 6
Text Book 3: Ch. 3, 4

Module – 3	08 Hrs

Terrain, Basin Asset Modelling and Documentation:

- Terrain modelling using DEM, contours, slopes, profiles, sections, river alignments, floodplain extents, and site context.
- Modelling and representation of basin infrastructure assets such as canals, culverts, embankments, retaining structures, barrages, dams, spillways, tunnels, pump stations, regulator structures, and control/service buildings.
- Preparation of general arrangement drawings, construction views, model sheets, material schedules, quantity summaries, and asset registers from model-based workflows.
- Linking spatial features with asset information, structural details, hydraulic function, maintenance data, and risk/exposure attributes.
- Model limitations, scale issues, level of information need, and practical considerations in project-level river basin representation.

Text Book 1: Ch. 7, 8, 9
Text Book 2: Ch. 7, 8
Text Book 3: Ch. 5, 6

Module – 4	08 Hrs

Hydro-GIS Coordination, Model Validation and Spatial Risk Review:

- Integration of terrain, GIS layers, survey data, drainage/floodplain context, and BIM/civil asset models for river basin planning and review.
- Multidisciplinary model coordination for civil, structural, hydraulic, geotechnical, tunnel, powerhouse, electromechanical, and site-interface information.
- Spatial risk review: floodplain exposure, drainage bottlenecks, encroachment, access constraints, terrain conflicts, and infrastructure interface issues.
- Model validation and information-quality checks: georeferencing, naming, classification, asset attributes, revision status, model completeness, and coordination issues.
- Issue logging, model review, design review reporting, and BIM-on-site / BIM2Field information workflows.

Text Book 1: Ch. 10, 11, 12
Text Book 2: Ch. 9, 10, 11
Text Book 3: Ch. 7, 8, 9

Module – 5	08 Hrs

4D/5D Awareness, Analysis Data Models and Portfolio Delivery:

- Preparation of maps, model sheets, thematic layers, drawings, schedules, quantity/material summaries, asset registers, and coordination reports.
- Introductory 4D/5D applications for river basin infrastructure: construction

sequencing, excavation staging, access planning, quantity/cost linkage, and progress review.

- Data requirements for hydrologic and hydraulic analysis: geometry simplification, terrain context, sections, material data, boundary conditions, loads, water levels, and model-output feedback.
- Asset handover and lifecycle information: as-built/record information, inspection data, maintenance attributes, and digital twin awareness
- Final portfolio compilation: GIS layers, model files, maps, drawings, schedules, issue logs, analysis/interface notes, and reflective workflow report.

Text Book 1: Ch. 13, 14, 15
Text Book 2: Ch. 12, 13
Text Book 3: Ch. 10, 11, 12

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the basics of BIM, GIS, Hydro-GIS, GeoBIM, and river basin workflows.
CO2	Prepare spatial data, terrain models, and basin asset information for river basin projects.
CO3	Develop basic BIM-Hydro-GIS models for river basin assets.
CO4	Analyze integrated BIM-GIS models for conflicts, flooding, drainage, constructability, and data quality.
CO5	Evaluate integrated maps, drawings, schedules, quantities, and reports using BIM–Hydro–GIS/VDC workflows for a selected river basin project.

Text Books	
1	Rafael Sacks, Ghang Lee, Luciana Burdi and Marzia Bolpagni, *BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers*, John Wiley & Sons, 4th Edition, 2025, ISBN: 9781394222223.
2	Peter A. Burrough, Rachael A. McDonnell and Christopher D. Lloyd, Principles of Geographical Information Systems, Oxford University Press, 3rd Edition, 2015, ISBN: 9780198742845.
3	David R. Maidment, Handbook of Hydrology, McGraw-Hill, 1st Edition, 1993, ISBN: 9780070397323. McGraw Hill Education
4	Chow, V. T., Maidment, D. R. and Mays, L. W., Applied Hydrology, McGraw-Hill, 1st Edition, 1988, ISBN: 9780070108103.

Reference Books	
1	**I**SO**,** *ISO 19650-1: BIM Information Management – Concepts and Principles*, International Organization for Standardization, 1st Edition, 2018.
2	ISO**,** *ISO 19650-2: BIM Information Management – Delivery Phase*, International Organization for Standardization, 1st Edition, 2018.
3	Building SMART International**,** *Industry Foundation Classes (IFC) – open BIM Standard*, building SMART International, Current Edition, 2026.
4	Building SMART International**,** *Building Collaboration Format (BCF)*, building SMART International, Current Edition, Current Year
5	QGIS Development Team**,** *QGIS Documentation*, QGIS Project, Current Edition, Current Year.
6	U.S. Army Corps of Engineers, Hydrologic Engineering Center**,** *HEC-HMS Technical Reference and User Documentation*, Hydrologic Engineering Center, Current Edition, Current Year, ISBN: N/A.
7	U.S. Army Corps of Engineers, Hydrologic Engineering Center**,** *HEC-RAS User's Manual and Hydraulic Reference Manual*, Hydrologic Engineering Center, Current

	Edition, Current Year, ISBN: N/A.

Web links and Video Lectures (e – Resources)	
1	ISO 19650 introductory resources for BIM information management.
2	Building SMART resources on open BIM, IFC and interoperability.
3	Official QGIS, GRASS GIS and SAGA GIS documentation for spatial analysis, raster processing and DEM workflows.
4	HEC-HMS, HEC-RAS and EPA SWMM documentation/tutorials for basic hydrologic and hydraulic modelling exposure
5	Government basin planning, flood mapping, dam safety and water infrastructure manuals.
6	Industry case studies on BIM/VDC in hydropower, dams, tunnels, hydraulic structures, powerhouses and BIM-on-site workflows.
7	GIS learning and hydrology teaching materials from NPTEL/SWAYAM, official agencies and open educational repositories.

	PRACTICAL COMPONENT	**(LI- 28 Hrs)**
1	GIS and BIM-GIS workspace setup using a selected river basin case.	
2	Coordinate system selection, georeferencing, and base map preparation.	
3	DEM import, contour generation, terrain visualization, slope/profile extraction.	
4	Drainage network, river alignment, floodplain/context layer preparation.	
5	Basin infrastructure asset mapping: canal, culvert, embankment, barrage, dam, tunnel, powerhouse, pump station, or related asset.	
6	Basic BIM/civil asset modelling or model review of selected basin infrastructure elements.	
7	BIM-GIS alignment and asset information linking using IDs, location, type, status, capacity, condition, and risk attributes.	
8	Spatial risk and coordination review: exposure, encroachment, access, bottleneck, and interface issues.	
9	Preparation of maps, model views, issue log, schedules, and final portfolio presentation.	

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	Hydro-GIS mini-project: terrain, asset layers, model views and issue log.	25
	OR	
2	Spatial risk and asset exposure portfolio for a selected river basin reach or facility.	25
	OR	
3	Open-book team challenge on basin coordination, information quality and issue identification.	25
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	MOOCs / online certification on GIS, hydraulic infrastructure, information management or digital construction	25
	OR	
2	Tool and software exploration using approved GIS, hydraulic, openBIM or civil infrastructure tools.	25
	OR	
3	Competitive aptitude and concept practice in GIS, hydraulic infrastructure and BIM-GIS information workflows.	25

CO – PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1		2	2
CO2	2	3	2		3	2
CO3	2	3	3		3	2
CO4	2	3	3	3	3	3
CO5	2	3	3	2	3	3

Semester: I						
BIM FOR INFRASTRUCTURE ENGINEERING AND MANAGEMENT						
Course Code	**:**	**1MCV104G**		**Credits**	**:**	04
Hours/Week (L: T: P)	**:**	70(3:0:2)		**CIE**	**:**	50 Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	120(42:0:28:50)		**SEE**	**:**	50 Marks
Course Type	**:**	IPCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Engineering Surveying, Construction Management, GIS, BIM
Knowledge on Fundamental Concepts	Basic surveying, GIS, infrastructure planning, construction management and BIM concepts
Knowledge on Connected Tools (If any)	AutoCAD/Civil 3D, Revit, Civil 3D/Infra Works, QGIS, MS Excel

Course Learning Objectives: This course will enable the students to	
CLO1	Explain BIM concepts and information management for infrastructure projects.
CLO2	Determine the survey, GIS, utility and asset information required for infrastructure projects.
CLO3	Develop fit-for-purpose BIM models for infrastructure elements.
CLO4	Validate infrastructure information using BIM standards, data exchange and CDE workflows.
CLO5	Evaluate coordination, construction, quantity, scheduling, site management, handover and asset management issues.

Module – 1	**8 Hrs**

BIM Fundamentals and Infrastructure Information Management:

- BIM for infrastructure as information management, not only 3D modelling or software use.
- Traditional workflow versus BIM enabled workflow for Greenfield and brownfield infrastructure projects.
- Infrastructure systems in an airport: roads, bridges, culverts, tunnels, utilities, drainage, side works.
  Conveyor belts and public assets.
- Information requirements: purpose, decision, responsible party, format, accuracy, status, revision, approval and acceptance.
- CDE workflow, naming, metadata, version control, issue records, OpenBIM awareness and model/data deliverables.

Text Book 1: Ch. 1, 2, 3, 4

Text Book 2: Ch. 1, 2, 3, 4

Text Book 3: Ch. 1, 2, 3

Module – 2	**08 Hrs**

Site Information, Survey/GIS Inputs and Model Setup:

- Existing-condition information for infrastructure: topographic survey, coordinate system, datum, terrain/DTM, GIS context and alignment/chainage.
- Brownfield data risks: legacy drawings, hidden utilities, live traffic/operations, restricted access, unknown as-built conditions and environmental/site constraints.
- Survey and reality-capture awareness: total station/GNSS, drone imagery, LiDAR/point cloud, 360 capture, GPR/utility detection and condition/progress evidence.
- Preparing data requests and selecting appropriate specialists: surveyor, GIS specialist, utility detection team, geotechnical team, BIM coordinator and site

team.
- Project setup in BIM/CDE: alignment, corridor, levels, zones, work packages, model status and assumptions register.

Text Book 1: Ch. 3, 4, 5
Text Book 2: Ch. 4, 5, 6
Text Book 3: Ch. 4, 5, 6

Module – 3	08 Hrs

Infrastructure Modeling and Information Structuring:

- Fit-for-purpose modelling of terrain, roads, pavements, junctions, drainage, utilities, culverts, retaining structures and bridge/tunnel interfaces.
- Model breakdown for linear infrastructure: corridor, chainage, zone, system, package, structure and asset object.
- Required information: geometry, levels, clearances, quantities, classification, asset IDs, property data, assumptions and model limitations.
- OpenBIM and exchange awareness: IFC/IFC 4.3 concepts, BCF issue communication, LandXML/GIS context and basic asset-data tables.
- Model quality checks: georeferencing, duplicates, omissions, naming, data completeness, quantity readiness and interoperability.

Text Book 1: Ch. 5, 6, 7
Text Book 2: Ch. 6, 7, 8
Text Book 3: Ch. 7, 8, 9

Module – 4	08 Hrs

Site Management, Quantity Extraction and Infrastructure Coordination:

- Construction-stage use of BIM information for site management, staging, constructability, coordination and project control.
- Coordination review: utility conflicts, drainage conflicts, clearance issues, bridge/culvert/tunnel interfaces, temporary works awareness and safety/public-interface risks.
- Site logistics: access, work zones, traffic diversion, plant/material movement, excavation zones, environmental controls and phased construction.
- Quantity take-off and project-control outputs: earthwork, pavement, concrete, reinforcement, drainage/utilities, change records and quantity assumptions.
- Progress verification and issue control using model views, field records, drone/point-cloud/360 evidence, RFIs, BCF-style issue logs and closure reports.

Text Book 1: Ch. 6, 7, 8
Text Book 2: Ch. 8, 9, 10, 11
Text Book 3: Ch. 8, 9, 10

Module – 5	08 Hrs

Infrastructure Documentation, As-built Handover and Portfolio Delivery:

- Infrastructure drawing and documentation outputs: plans, profiles, cross-sections, sheets, schedules, quantities, issue logs and review records.
- As-built and handover information: verified site records, buried utility evidence, asset registers, operation and maintenance data, inspection zones and maintainability attributes.
- PIM to AIM transition: what project information must become usable asset information for owner/FM and operation and maintenance teams.
- Digital twin readiness: linking BIM, GIS, asset data, inspection records, sensors/work orders and dashboards without claiming a full operational twin.
- Final portfolio: information request, model/data package, coordination log, site-

management output, quantities, handover table and reflective report.

Text Book 1: Ch. 8, 9

Text Book 2: Ch. 10, 11, 12

Text Book 3: Ch. 10, 11

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain BIM workflows for infrastructure planning, design, construction, handover and operation.
CO2	Identify survey, GIS, utility, geotechnical and site information required for infrastructure projects.
CO3	Develop infrastructure models using terrain, alignment, drainage, utilities and structures.
CO4	Validate infrastructure information using standards, metadata, revisions and data exchange workflows.
CO5	Evaluate coordination, construction, quantity, scheduling, progress and asset management of infrastructure projects.

Text Books	
1	C. Eastman, P. Teicholz, R. Sacks and K. Liston, BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers, John Wiley & Sons, 4th Edition, 2025, ISBN: 9781394222223.
2	Brad Hardin and Dave McCool, BIM and Construction Management: Proven Tools, Methods, and Workflows, John Wiley & Sons, 2nd Edition, 2015, ISBN: 9781118942765.
3	Mark Baldwin, The BIM Manager: A Practical Guide for BIM Project Management, BSI Publications, 1st Edition, 2019, ISBN: 9780533168149.
4	A. Baldwin and D. Bordoli, A Handbook for Construction Planning and Scheduling, Wiley-Blackwell, 2nd Edition, 2014, ISBN: 9781118334331.
5	B. Kumar, A Practical Guide to Adopting BIM in Construction Projects, Whittles Publishing, 1st Edition, 2021, ISBN: 9781849954684.

Reference Books	
1	buildingSMART International**,** *openBIM, IFC, BCF, IDS and bSDD Resources*, buildingSMART International.
2	International Organization for Standardization (ISO)**,** *ISO 19650 – Information Management Using BIM*, ISO, Current Edition, 2018.
3	RICS**,** *Information Management and Digital Construction Guidance*, Royal Institution of Chartered Surveyors.
4	UK BIM Framework**,** *Guidance on BIM Information Management and Common Data Environment*, UK BIM Framework.
5	CPWD/BIS/NBC**,** *BIM and Infrastructure Information Management Guidelines and Case Studies*, Government/Standards Organizations.

Web links and Video Lectures (e – Resources)	
1	NPTEL / SWAYAM modules on BIM, GIS, construction management, surveying, planning and digital construction.
2	buildingSMART International resources on IFC, BCF, IDS, bSDD and openBIM workflows.
3	QGIS, CloudCompare, WebODM/OpenDroneMap, Potree, IfcOpenShell, Bonsai/BlenderBIM and BCF tool documentation.
4	Public infrastructure BIM case studies covering roads, bridges, tunnels, utilities, airports, asset handover and digital delivery.
5	Software Tools:

6	BIM/civil tools: Civil 3D, InfraWorks, Bentley OpenRoads/OpenBridge/OpenBuildings, Revit, Tekla or equivalent.
7	Coordination/site tools: Navisworks, Solibri, BIMcollab, Revizto, Synchro/4D tools, ACC/ProjectWise/CDE platforms or equivalent.
8	GIS/reality-capture tools: QGIS, ArcGIS, CloudCompare, WebODM/OpenDroneMap, Pix4D/Metashape, Potree or equivalent.
9	Open-source/learning tools: Bonsai/BlenderBIM, IfcOpenShell, FreeCAD, BIM Vision/xBIM viewers.

	PRACTICAL COMPONENT	**(LI- 28 Hrs)**
1	BIM/CDE workspace setup for an infrastructure project: folders, naming, status, revision and responsibility matrix.	
2	Prepare an infrastructure information request covering survey, GIS, utility, geotechnical, reality-capture and asset data.	
3	Review or create terrain/site-context data using survey/GIS/DEM inputs; document coordinate system, datum and assumptions.	
4	Prepare a brownfield information risk register covering utilities, access, live operations, environmental constraints and missing as-built data.	
5	Develop a fit-for-purpose corridor model with road/drainage/utility information and one bridge, culvert or tunnel interface.	
6	Add classification, asset IDs, key properties, quantities and model limitations suitable for coordination and reporting.	
7	Inspect or export OpenBIM/coordination outputs using IFC/BCF/LandXML/GIS context where available; record exchange issues.	
8	Conduct coordination review and prepare clash/clearance/constructability issue logs with responsibility and closure status.	
9	Prepare a site-management and handover portfolio including 4D/staging view, logistics note,progress/as-built evidence and asset-data table.	

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	Brownfield infrastructure information mini-project: data request, survey/GIS review, CDE setup and risk register.	25
	OR	
2	Infrastructure coordination and site-management portfolio: corridor model, utility/drainage issue log, staging/logistics and progress evidence.	25
	OR	
3	Handover and asset-information portfolio: as-built evidence, asset-data table, operation and maintenance fields and digital-twin readiness note.	25
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	MOOCs / online certification on BIM, GIS, surveying awareness, construction planning or infrastructure information management.	25
	OR	
2	Tool and dataset exploration using approved BIM, GIS, CDE, coordination, reality-capture or OpenBIM tools.	25
	OR	
3	Case-study review of brownfield infrastructure delivery, utility coordination, site monitoring, handover or asset information workflows.	25

CO – PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1	2	1
CO2	2	3	2	2	3	2
CO3	2	3	3	2	3	2
CO4	2	3	2	3	3	2
CO5	2	3	3	3	3	3

Semester: I						
INTEGRATED BIM & COMPUTER AIDED DESIGN FOR TRANSPORTATION SYSTEMS						
Course Code	**:**	1MCV104H		**Credits**	**:**	04
Hours/Week (L: T: P)	**:**	70(3:0:2)		**CIE**	**:**	50 Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	120(42:0:28:50)		**SEE**	**:**	50 Marks
Course Type	**:**	IPCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Transportation Engineering, Surveying and CAD
Knowledge on Fundamental Concepts	Basic knowledge of highways, surveying, GIS, CAD and construction
Knowledge on Connected Tools (If any)	Basic knowledge of AutoCAD, GIS and BIM software

Course Learning Objectives: This course will enable the students to	
CLO1	Describe the fundamentals of BIM, GIS, GeoBIM, CDE and information management for transportation infrastructure.
CLO2	Apply GIS, surveying, terrain and reality-capture data for existing-condition assessment of highway projects.
CLO3	Develop basic BIM/GIS models and documentation for highway infrastructure assets.
CLO4	Analyze quantity take-off, OpenBIM, information checking and coordination workflows.
CLO5	Evaluate 4D/5D BIM, site management, asset handover, digital twin and remodelling workflows.

Module – 1	**8 Hrs**

Feasibility, Transportation System Framing and BIM/GeoBIM Foundations:

- Transportation infrastructure lifecycle from need identification to procurement, construction, handover, operation, maintenance, renewal, and retrofit.
- Highway as a transportation system-of-systems: carriageway, shoulder, median, intersections, service roads, drainage, utilities, structures, traffic control, and stakeholders.
- Feasibility inputs: land/right-of-way, access, safety, environmental constraints, traffic demand, cost, phasing, and future expansion.
  BIM, GIS, and GeoBIM concepts: BIM as structured asset/project information, GIS as spatial/network context, and GeoBIM as integration of project models, geospatial context, and asset data.
- Information management: CDE-style folders, information containers, naming, revision/status, review/approval, Level of Information Need, asset IDs, classification, object type libraries, and information requirement checklists.
- OpenBIM foundations: IFC/IFC 4.3 awareness, BCF issue exchange, IDS-style checking, neutral model viewing, and vendor-neutral information delivery.

Text Book 1: Ch. 1, 2, 5
Text Book 2: Ch. 1, 2
Text Book 3: Ch. 1, 2

Module – 2	**08 Hrs**

Existing Conditions, Planning Data and Highway System Modelling:

- Existing-condition information: GIS base maps, terrain/DEM, survey points, land parcels, right-of-way, drainage, utilities, environmental constraints, traffic/access data, open data sources, and legacy records.

- Reality-context inputs: drone imagery, photogrammetry, LiDAR/mobile mapping, laser scanning, point clouds, inspection photographs, and legacy drawings.
- Data architecture: asset IDs, georeferencing, coordinate systems, chainage/linear referencing, GIS layers, relational tables, and spatial databases.
- Highway asset representation: corridor/access road, junction, pavement, drainage, utility corridor, bridge/culvert, service road, and traffic management zone.
- Tool awareness: QGIS/PostGIS, GeoServer, QField/Mergin Maps, OpenStreetMap/open data, pgRouting, GRASS/SAGA GIS, CloudCompare, Bonsai/FreeCAD, and IFC viewers.

Text Book 1: Ch. 2, 3, 5
Text Book 2: Ch. 2, 4
Text Book 3: Ch. 3, 4

Module – 3	**08 Hrs**

Documentation, Quantities, OpenBIM and Information Checking:

- Model-based deliverables: plans, profiles, sections, sheets, schedules, asset lists, drawings, reports, and design review packages.
- Quantity take-off: pavement, earthwork, drainage, utilities, structures, and selected highway components using schedules, spreadsheets, and IFC data.
- OpenBIM and interoperability: IFC/IFC 4.3 basics, neutral model viewing, BCF issue exchange, BIM-GIS exchange, and checks for geometry, properties, classification, and asset IDs.
- Information checking: IDS-style requirements, required properties, object classification, bSDD awareness, property-set review, and model-quality checklists.
- Coordination and interface management: runway/taxiway-lighting-drainage style logic replaced by highway interfaces such as pavement-drainage, road-utility, access road-structure, junction-drainage, and safety zones.
- Linked information awareness: connect model elements to drawings, specifications, issues, quantities, documents, GIS locations, and future asset records using consistent IDs.

Text Book 1: Ch. 3, 5, 6
Text Book 2: Ch. 4, 5, 6
Text Book 3: Ch. 6, 9

Module – 4	**08 Hrs**

Coordination, Construction Logistics, Site Management and Reality Capture:

- Construction planning for live highway environments: work zones, temporary works, safety zones, material laydown, access routes, equipment movement, emergency access, and inspection points.
- Highway phasing and logistics: lane closures, traffic diversions, temporary access, utility relocation, work sequencing, and night/possession-style planning.
- Road and rail embedded cases are represented in highway context as access-road widening, traffic diversion, utility relocation, bridge/culvert works, precast delivery, earthwork haul routes, and public disruption control.
- 4D/5D workflows: link model/asset IDs to schedule and quantity tables, staging diagrams, progress planning, and cost/schedule impact awareness.
- Coordination workflows: BCF-style issue exchange, interface registers, risk notes, responsibility tracking, decision logs, and coordination meeting outputs.

Reality capture and field data: point cloud or photo evidence, mobile inspection data, model-vs-site comparison, deviation reporting, and update of as-built/FM information.

Text Book 1: Ch. 6, 8
Text Book 2: Ch. 5, 6
Text Book 3: Ch. 3, 6, 7

Module – 5	08 Hrs

Handover, FM, Linked Data, Digital Twin Workflows and Remodelling:

- Asset handover: asset registers, asset IDs, location, classification, properties, inspection history, warranties/manual references, maintenance schedule, acceptance data, and Asset Information Model concepts.
- FM and operations: pavement inspections, lighting/drainage maintenance, signage and safety furniture, access-road maintenance, and structure maintenance.
- Linked Data as practical workflow: connect BIM objects, GIS locations, documents, inspection records, work orders, maintenance history, and dashboards using consistent asset IDs and traceable links.
- Digital twin awareness: model + GIS context + live/periodic data + inspection records + maintenance actions + decision dashboard.
- Remodelling and retrofit: scan-to-BIM, widening, rehabilitation, junction improvement, and sustainability upgrades with operational phasing.
- Portfolio evaluation: determine whether the workflow supports lifecycle decisions, not just whether a model looks visually complete.

Text Book 1: Ch. 4, 6, 9
Text Book 2: Ch. 6, 7, 8
Text Book 3: Ch. 8, 9, 12

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the transportation infrastructure lifecycle using BIM, GIS, GeoBIM and CDE.
CO2	Prepare highway project information using GIS, survey, terrain and reality-capture data.
CO3	Develop BIM/GIS models of highway assets such as roads, drainage, utilities, bridges and culverts.
CO4	Analyze quantities, Open BIM, information checking and coordination workflows.
CO5	Analyze construction, site management, 4D/5D BIM, asset management, digital twins and remodeling.

Text Books	
1	Rafael Sacks, Ghang Lee, Luciana Burdi and Marzia Bolpagni, BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers, John Wiley & Sons, 4th Edition, 2025, ISBN: 9781394222223.
2	Brad Hardin and Dave McCool, BIM and Construction Management: Proven Tools, Methods, and Workflows, John Wiley & Sons, 2nd Edition, 2015, ISBN: 9781118942765.
3	Andrew Baldwin and David Bordoli, A Handbook for Construction Planning and Scheduling, John Wiley & Sons, 1st Edition, 2014, ISBN: 9780470670323.
4	Pieter Pauwels and Kris McGlinn, Buildings and Semantics: Data Models and Web Technologies for the Built Environment, Routledge, 1st Edition, 2020, ISBN: 9780367136024.
5	Markus Nöldgen, BIM in Bridge and Infrastructure Design, Springer Vieweg, 1st Edition, 2022, ISBN: 9783658368005.

6	Lester A. Hoel, Nicholas J. Garber and Adel W. Sadek, Transportation Infrastructure Engineering: A Multimodal Integration, Cengage Learning, 1st Edition, 2010, ISBN: 9780495667896.

Reference Books	
1	Building SMART International, *Open BIM, IFC and Interoperability Documentation*, building SMART International.
2	British Standards Institution (BSI)**,** *BS 1192: Collaborative Production of Architectural, Engineering and Construction Information – Code of Practice*, BSI.
3	International Organization for Standardization (ISO)**,** *ISO 19650: Organization and Digitization of Information about Buildings and Civil Engineering Works, Including Building Information Modelling (BIM) – Information Management Using BIM*, ISO.
4	Central Public Works Department (CPWD)**,** *Introducing BIM in CPWD*, Government of India, 2024.
5	Various Institutional Authors**,** *Institutional BIM Guidelines, Execution Planning Documents and Project Scheduling Manuals*, Respective Institutions.
6	U.S. General Services Administration (GSA)**,** *National 3D-4D-BIM Program and BIM Guide Series*, U.S. General Services Administration.

Web links and Video Lectures (e – Resources)	
1	NPTEL / SWAYAM modules related to BIM, project planning, construction management, and digital construction.
2	Building SMART resources on open BIM, IFC, and collaborative model use in project delivery.
3	Official software learning portals and guided tutorials for BIM-based sequencing, coordination, and construction simulation tools.
4	Public BIM case studies from Norway, Singapore, Europe, the United States and India.

	PRACTICAL COMPONENT	**(LI- 28 Hrs)**
1	BIM/CDE workspace setup for an infrastructure project: folders, naming, status, revision and responsibility matrix.	
2	Prepare an infrastructure information request covering survey, GIS, utility, geotechnical, reality-capture and asset data.	
3	Review or create terrain/site-context data using survey/GIS/DEM inputs; document coordinate system, datum and assumptions.	
4	Prepare a brownfield information risk register covering utilities, access, live operations, environmental constraints and missing as-built data.	
5	Develop a fit-for-purpose corridor model with road/drainage/utility information and one bridge, culvert or tunnel interface.	
6	Add classification, asset IDs, key properties, quantities and model limitations suitable for coordination and reporting.	
7	Inspect or export OpenBIM/coordination outputs using IFC/BCF/LandXML/GIS context where available; record exchange issues.	
8	Conduct coordination review and prepare clash/clearance/constructability issue logs with responsibility and closure status.	
9	Prepare a site-management and handover portfolio including 4D/staging view, logistics note, progress/as-built evidence and asset-data table.	

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	Transportation BIM modeling mini-project: alignment, profile, corridor, and sections.	25
	OR	
2	Quantity and schedule portfolio: earthwork, pavement, and	25

	drainage mapping.	
	OR	
3	Open-book team challenge on transportation coordination and review comments.	25
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	MOOCs / online certification on BIM and transportation design.	25
	OR	
2	Tool and software exploration using approved BIM /transportation design tools.	25
	OR	
3	Competitive aptitude and concept practice in highway geometry, corridor design, and BIM workflows.	25

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	2	1	2	2
CO2	2	3	2	3	3	2
CO3	3	2	3	2	3	2
CO4	2	3	3	3	3	2
CO5	2	3	3	2	3	3

Semester: I						
GEOSPATIAL DATABASE MANAGEMENT SYSTEMS AND PROGRAMMING SKILLS						
Course Code	**:**	1MCV104 I		**Credits**	**:**	04
Hours/Week (L: T: P)	**:**	70(3:0:2)		**CIE**	**:**	50 Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	120(42:0:28:50)		**SEE**	**:**	50 Marks
Course Type	**:**	IPCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Database Management Systems, GIS and Programming
Knowledge on Fundamental Concepts	Basic knowledge of databases, GIS, spatial data and programming
Knowledge on Connected Tools (If any)	Basic knowledge of SQL, Python and GIS software

Course Learning Objectives: This course will enable the students to	
CLO1	Describe the fundamentals of geospatial data, databases, spatial databases and coordinate systems.
CLO2	Apply database concepts to organize, store and manage geospatial data.
CLO3	Develop basic programs and scripts for processing and automating geospatial data.
CLO4	Analyze spatial queries, relationships, indexing, topology and data quality in geospatial databases.
CLO5	Evaluate the integration of GIS, remote sensing, programming, interoperability and data governance for engineering applications.

Module – 1	**8 Hrs**

Fundamentals of geospatial data and database systems:

- Introduction to geospatial information systems and their relevance to civil engineering, transportation, urban planning, water resources, environmental monitoring, and infrastructure management.
- Types of geospatial data: vector, raster, attribute data, metadata, temporal data, and 2D/3D geospatial representations.
- Fundamentals of database systems: data models, DBMS concepts, relational databases, tables, keys, relationships, normalization, and transaction basics.
- Spatial data characteristics: location, geometry, topology, scale, accuracy, precision, resolution, and uncertainty in geospatial datasets.
- Coordinate systems, map projections, datums, geo-referencing principles, and the significance of spatial reference management in database environments.

Text Book 1: Ch. 1, 2, 3, 4

Text Book 3: Ch. 1, 2, 3, 4

Module – 2	**08 Hrs**

Spatial database design and geospatial data management:

- Spatial database concepts: geodatabases, spatial tables, geometry types, feature classes, layers, schemas, and attribute domain management.
- Design of geospatial databases for engineering applications involving parcels, utilities, transportation networks, drainage, terrain, land use, and asset inventories.
- Data creation and management: importing shapefiles, CAD layers, CSV data, GPS observations, remote sensing outputs, and field survey records into a spatial database.
- Entity relationships, primary and foreign keys, constraints, validation rules,

topology rules, and methods for maintaining consistency in spatial datasets.

- Storage formats, open standards, interoperability concepts, and introduction to spatially enabled database platforms and open-source GIS database environments.

Text Book 1: Ch. 5, 6, 7

Text Book 3: Ch. 7, 8, 9

Module – 3	08 Hrs

Querying, indexing and analysis in geospatial DBMS:

- Structured querying concepts for spatial data: attribute queries, selection operations, filtering, sorting, aggregation, joins, and relationship-based retrieval.
- Spatial queries using location-based conditions such as intersection, containment, proximity, buffering, adjacency, overlay logic, and nearest-neighbour search.
- Concept of spatial indexing and its role in improving the performance of large geospatial datasets and repeated query execution.
- Data integrity and quality review: duplicates, null values, slivers, geometry errors, topology violations, and methods for error detection and correction.
- Generation of thematic outputs, summary tables, query reports, and analytical views to support planning, design, and decision-making.

Text Book 1: Ch. 8, 9, 10

Text Book 3: Ch. 13, 14, 15

Module – 4	08 Hrs

Programming skills for geospatial data processing and automation:

- Introduction to programming logic for GIS applications: variables, data types, operators, control structures, functions, file handling, and modular scripting concepts.
- Scripting for geospatial workflows using appropriate programming environments for reading, transforming, filtering, and exporting spatial and tabular data.
- Automation of repetitive GIS tasks such as batch layer processing, coordinate conversion, attribute updates, field calculations, and data validation.
- Basic use of libraries or tools for spatial data manipulation, map layer handling, database connectivity, and simple geospatial analysis.
- Script-based generation of outputs, logs, summaries, and reproducible workflows for engineering data management.

Text Book 1: Ch. 11, 12, 13

Text Book 3: Ch. 6, 13, 15

Module – 5	08 Hrs

Integration, applications and governance of geospatial information systems:

- Integration of geospatial databases with desktop GIS, web GIS, remote sensing products, surveying workflows, BIM/GIS linkages, and infrastructure information systems.
- Applications in civil engineering: utility mapping, urban infrastructure planning, terrain and watershed studies, transportation asset management, environmental analysis, and disaster management support.
- Multi-user editing, versioning concepts, data sharing, interoperability, metadata

standards, and collaborative geospatial project practices.

- Data governance issues including data security, privacy, ethics, ownership, quality assurance, backup, and sustainable maintenance of geospatial repositories responsible use of geospatial information.
- Emerging directions such as cloud geodatabases, digital twins, real-time geospatial systems, AI-assisted spatial analytics, and smart-city decision support.

Text Book 1: Ch. 14, 15, 16

Text Book 3: Ch. 10, 16, 17, 18

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the concepts of geospatial data, spatial databases, database management systems, coordinate reference frameworks, and the role of geospatial information in civil engineering and infrastructure applications.
CO2	Create and manage geospatial databases by organizing spatial and non-spatial datasets, defining schemas, importing layers, and applying database operations using suitable GIS and database tools.
CO3	Develop basic programs and scripts for querying, processing, validating, and automating geospatial data handling tasks using programming skills relevant to GIS workflows.
CO4	Analyse spatial relationships, data integrity issues, indexing needs, topology constraints, and query performance in geospatial database environments.
CO5	Evaluate the integration of geospatial databases, GIS, remote sensing, programming, interoperability, and data governance for sustainable and scalable engineering decision-support systems.

Text Books	
1	Ramez Elmasri and Shamkant B. Navathe**,** *Fundamentals of Database Systems*, Pearson Education, 7th Edition, 2017**,** ISBN: 9789332582705**.**
2	Shashi Shekhar, Hui Xiong and Xun Zhou, *Encyclopedia of GIS*, Springer, 3rd Edition, Current Edition**,** ISBN: 978-3-319-23519-6**.**
3	Paul A. Longley, Michael F. Goodchild, David J. Maguire and David W. Rhind, *Geographic Information Systems and Science*, John Wiley & Sons, 4th Edition, 2015**,** ISBN: 9781118676950**.**
4	Paul A. Zandbergen, *Python Scripting for ArcGIS Pro*, Esri Press, 3rd Edition, 2024, ISBN: 9781589488014**.**

Reference Books	
1	C. J. Date, A. Kannan and S. Swamynathan, *An Introduction to Database Systems*, Pearson Education, 8th Edition, 2006, ISBN: 9788177585568**.**
2	Regina O. Obe and Leo S. Hsu**,** *PostGIS in Action*, Manning Publications, 3rd Edition, 2021, ISBN: 9781617296697**.**
3	Open-source GIS and Python development communities**,** *Open-Source GIS and Python Geospatial Documentation*, Respective Organizations.
4	Government and relevant agencies**,** *Spatial Data Management and Geospatial Standards Manuals*, Respective Government/Agency Publications.

Web links and Video Lectures (e – Resources)	
1	NPTEL courses on database management systems and GIS programming.
2	SWAYAM resources on Python programming and data analytics.
3	PostgreSQL/Post GIS documentation for spatial database operations.
4	Python geospatial documentation and tutorials for spatial data processing.
5	Open-source GIS software tutorials for automation and scripting.

	PRACTICAL COMPONENT	(LI- 28 Hrs)
1	Create a geospatial database schema for sample spatial and attribute data.	
2	Import spatial and non-spatial datasets into a database or GIS environment.	
3	Write SQL queries for spatial and attribute data retrieval.	
4	Perform spatial operations such as buffer, intersect, and overlay using scripts.	
5	Read, clean, and transform geospatial data using Python.	
6	Generate thematic maps and exploratory visualizations from geospatial data.	
7	Automate a repetitive geospatial task using a script.	
8	Integrate database queries with a programming workflow for analysis.	

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	**Design a spatial database for a real or sample application.** Define entities, attributes, keys, relationships, and schema for a GIS application such as land records, water supply, solid waste, or environmental monitoring. Prepare ER diagram and relational schema.	25
	OR	
2	**Develop SQL-based geospatial queries.** Write queries for selection, filtering, joins, proximity search, attribute analysis, and spatial retrieval. Include query explanation and result interpretation.	25
	OR	
3	**Build a Python geospatial preprocessing workflow.** Read spatial files, clean data, convert formats, handle missing values, and generate derived layers or summary tables using scripts or notebooks.	25
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	**Explore PostgreSQL/PostGIS basics.** Learn database creation, table design, geometry types, and simple spatial queries. Prepare a short note with examples.	25
	OR	
2	**Study Python libraries for geospatial work.** Explore pandas, geopandas, shapely, matplotlib, or equivalent tools and summarize their uses with one mini example	25
	OR	
3	**Create a mini case study.** Choose one application such as flood mapping, land-use analysis, transport routing, or utility network analysis and explain how database and programming support the solution.	25

CO – PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	–	1	2	–
CO2	3	3	2	2	3	–
CO3	3	3	2	3	3	–
CO4	3	3	–	3	3	–
CO5	2	3	2	3	3	3

Semester: I						
Retrofitting & Rehabilitation of Structures						
Course Code	:	1MCV104J		**Credits**	:	3
Hours/Week (L: T: P)	:	70(3:0:2)		**CIE**	:	50 Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	:	120(42:0:28:50)		**SEE**	:	50 Marks
Course Type	:	IPCC		**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	Strength of Materials, Structural Analysis, RCC, Engineering Mechanics, Concrete Technology
Knowledge on Fundamental Concepts	Basics of structural analysis, RCC, materials, and earthquake engineering
Knowledge on Connected Tools (If any)	Basic NDT, structural detailing, BIM, and site inspection

Course Learning Objectives: This course will enable the students to	
CLO1	Explain the basic concepts of repair, strengthening, retrofitting, and rehabilitation of concrete structures.
CLO2	Describe procedures for damage assessment, crack evaluation, and testing of concrete structures.
CLO3	Analyze factors affecting serviceability, durability, and corrosion of concrete structures.
CLO4	Compare maintenance, repair, strengthening, and retrofitting techniques for concrete structures.
CLO5	Evaluate the suitability of materials and techniques for repair and retrofitting of damaged concrete structures.

Module – 1	**08 Hrs**
Fundamentals of Repair, Retrofitting and Rehabilitation: Introduction and definitions of repair, strengthening, retrofitting and rehabilitation of concrete structures. Causes of deterioration of concrete structures: physical, chemical and environmental causes. Types and assessment of structural damage due to earthquakes and basic principles of evaluating earthquake-damaged concrete structural elements. **Text Book 1:** Ch.1, Ch.2 **Text Book 2:** Ch.1, Ch.2	
Module – 2	**08 Hrs**
Damage Assessment and Testing of Concrete Structures: Purpose and importance of structural assessment. Preliminary/rapid assessment and detailed investigation of damaged structures. Identification and evaluation of surface and structural cracks. Procedure for assessment and evaluation of existing/damaged concrete structures. Destructive, non-destructive and semi-destructive testing methods for assessing concrete strength, condition and structural integrity. **Text Book 1:** Ch.3, Ch.4 **Text Book 2:** Ch.3, Ch.4	
Module – 3	**08 Hrs**
Serviceability, Durability and Corrosion of Concrete Structures: Effects of climate, temperature variations, chemical attack, wear and erosion on concrete structures. Effects of design and construction deficiencies on durability and serviceability. Corrosion mechanism of reinforcement, influence of concrete cover and cracking on corrosion. Methods of corrosion prevention and protection, including corrosion inhibitors,	

corrosion-resistant reinforcement, protective coatings and cathodic protection. Quality control and quality assurance in concrete construction.

Text Book 1: Ch.2, Ch.5, Ch.6
Text Book 2: Ch.5, Ch.6, Ch.7

Module – 4	**09 Hrs**

Maintenance, Repair and Retrofitting Techniques:

Definition, objectives and importance of maintenance of concrete structures. Need and principles of retrofitting. Retrofitting and strengthening of columns and beams using jacketing techniques. Externally Bonded Reinforcement (EBR) and Near Surface Mounted (NSM) techniques using FRP materials. External post-tensioning and section enlargement techniques. Basic guidelines and principles for seismic rehabilitation of existing buildings.

Text Book 1: Ch.7, Ch.8, Ch.9
Text Book 2: Ch.8, Ch.9, Ch.10

Module – 5	**09 Hrs**

Materials for Repair and Retrofitting: Fiber Reinforced Polymer (FRP) materials including CFRP, GFRP and AFRP, and natural fibers such as sisal and jute. Adhesive materials including epoxy resins. Special concretes, repair mortars and construction chemicals. Materials for accelerated strength gain. Rust removal and protective coatings for reinforcement during repair.

Repair Techniques: Foamed concrete, mortar and dry-pack techniques, vacuum concrete, gunite and shotcrete, epoxy injection and mortar repair of cracks. Principles and applications of shoring and underpinning for structural repair and rehabilitation.

Text Book 1: Ch.7, Ch.10
Text Book 1: Ch.11, Ch.12

	PRACTICAL COMPONENT	**(LI- 28 Hrs)**
1	Crack Identification: Identify and classify cracks in concrete specimens and suggest suitable repair methods.	
2	Rebound Hammer Test: Determine the surface hardness and estimate the compressive strength of concrete using a rebound hammer.	
3	Ultrasonic Pulse Velocity (UPV) Test: Assess the quality and uniformity of concrete using the UPV test.	
4	Concrete Core Test: Demonstrate the procedure for collecting concrete cores and determining compressive strength.	
5	Corrosion Assessment: Identify reinforcement corrosion in concrete specimens and study suitable corrosion protection methods.	
6	FRP Retrofitting: Demonstrate the application of Fiber Reinforced Polymer (FRP) sheets for strengthening concrete members.	
7	Crack Repair Techniques: Demonstrate epoxy injection and mortar repair techniques for concrete cracks.	
8	Jacketing Techniques: Prepare a model or demonstrate column and beam strengthening using reinforced concrete jacketing.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the basic principles of repair, strengthening, retrofitting and rehabilitation of damaged concrete structures.
CO2	Apply suitable damage assessment and testing methods to evaluate concrete structures.
CO3	Analyze the factors affecting the serviceability, durability and corrosion of concrete structures.
CO4	Evaluate suitable maintenance, repair and retrofitting techniques for existing concrete structures.
CO5	Design suitable repair and retrofitting solutions using appropriate materials and techniques.

Text Books	
1	Vidivelli, B., Rehabilitation of Concrete Structures, Standard Publishers Distributors, New Delhi, 1st Edition, Reprint 2021, ISBN: 978-81-8014-110-2.
2	Varghese, P. C., Maintenance, Repair & Rehabilitation and Minor Works of Buildings, PHI Learning Pvt. Ltd., New Delhi, 2014, ISBN: 978-81-203-4945-2
3	Allen, R. T. L., S. C. Edwards and D. N. Shaw, Repair of Concrete Structures, CRC Press, 1993, 1st Edition, ISBN: 978-0-367-86391-3.

Reference Books	
1	M. S. Shetty and Manish Mokal, Concrete Technology: Theory and Practice, S. Chand Publishing, 9th Edition, 2026, ISBN: 978-93-5501-420-7.
2	A. R. Santhakumar, Concrete Technology, Oxford University Press, 2nd Edition, 2018, ISBN: 978-0-19-945852-3.
3	Raouf Z. Obaidat, Structural Repair and Maintenance, Elsevier, 2010, ISBN: 978-1-84569-641-5.

Web links and Video Lectures (e–Resources)	
1	**WEB LINKS**: https://nptel.ac.in/courses/105106202
	https://nptel.ac.in/courses/105105213
	https://www.nptel.ac.in/courses/105106830
	https://www.concrete.org/topicsinconcrete/topicdetail.aspx?search=repair+of+concrete
2	**Video Lectures:** Maintenance and Repair of Concrete Structures – NPTEL Covers deterioration, corrosion, assessment, repair and maintenance. https://www.youtube.com/watch?v=x9noZ4xEXyg
	Maintenance and Repair of Concrete Structures – NPTEL (2026 Lecture) Useful for the overall concepts of repair, deterioration and rehabilitation. https://www.youtube.com/watch?v=F5XenXN9UrA
	NPTEL YouTube – Maintenance, Repair & Retrofitting Lectures https://www.youtube.com/@nptelhrd/search?query=retrofitting%20rehabilitation

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl.No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	**Assignment/Report**: Study of durability problems, reinforcement corrosion, serviceability issues and corrosion protection methods.	25
	OR	
2	**Seminar/Technical Report:** Study and presentation on modern repair materials and techniques such as FRP, epoxy injection, shotcrete, gunite, vacuum concrete, shoring and underpinning.	25
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl No.	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	**NPTEL/MOOC Module:** Fundamentals of structural repair, strengthening, retrofitting and rehabilitation of concrete structures.	25
	OR	
4	**NPTEL/MOOC/Video Lectures:** FRP strengthening, jacketing, NSM, EBR, external post-tensioning and seismic retrofitting techniques.	25

CO – PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2				
CO2	3	3		2	2	
CO3	3	3	2			2
CO4	3	3	3	2	2	
CO5	3	3	3	2	2	2

1MCV105X:
Professional Elective Courses-I

Semester: I						
ADVANCED REMOTE SENSING AND GIS						
Course Code	**:**	1MCV105A		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50 Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Basic Remote Sensing and GIS
Knowledge on Fundamental Concepts	Basic knowledge of remote sensing, GIS, surveying and spatial data
Knowledge on Connected Tools (If any)	Basic knowledge of QGIS, ArcGIS and image processing software

Course Learning Objectives: This course will enable the students to	
CLO1	Describe the basic principles of remote sensing, sensors and satellite data.
CLO2	Apply image processing techniques for remote sensing data analysis.
CLO3	Analyze GIS data models and spatial analysis techniques.
CLO4	Develop RS-GIS models for civil engineering applications.
CLO5	Evaluate GNSS, LiDAR, Photogrammetry, 3D modeling and AI/ML applications in geospatial engineering.

Module – 1	**08 Hrs**
Fundamentals of RS & Sensors: Introduction to remote sensing principles, electromagnetic radiation (EMR), spectral signatures of earth features (soil, water, vegetation, urban), platforms (airborne/spaceborne), sensors (optical, thermal, microwave - SAR), resolution types (spectral/spatial/temporal/radiometric), orbit types. Indian missions: IRS, Cartosat, RISAT; international: Landsat, Sentinel, MODIS. Image acquisition, preprocessing (geometric/radiometric correction). **Text Book 1:** Ch. 1 **Text Book 2:** Ch. 1 **Text Book 3:** Ch. 1	
Module – 2	**10 Hrs**
Advanced Image Processing: Digital image processing: enhancement (contrast stretch, filtering), classification (supervised/unsupervised, ML-based), change detection, accuracy assessment. Hyperspectral RS: data cubes, unmixing, anomaly detection. SAR processing: speckle filtering, interferometry (InSAR for DEM/ subsidence). Softwares: ERDAS, ENVI, SNAP. **Text Book 1:** Ch. 7 **Text Book 2:** Ch. 5 **Text Book 3:** Ch. 3	
Module – 3	**10 Hrs**
GIS Data Models & Analysis: GIS components, spatial data (raster/vector/hybrid), topology, data structures (shapefile, geodatabase). Spatial analysis: overlay, buffer, network, hydrology modeling. Attribute data management, queries (SQL), projections (UTM, Lambert), map algebra. Softwares: ArcGIS, QGIS. **Text Book 1:** Ch. 8 **Text Book 2:** Ch. 11 **Text Book 3:** Ch. 5	
Module – 4	**08 Hrs**

RS-GIS Applications:

Land use/land cover mapping, urban sprawl, watershed management, flood/landslide hazard zoning, transportation planning, infrastructure asset management. Integration models: cellular automata, agent-based. Case studies: ISRO/NRSC projects in engineering domain.

Text Book 1: Ch. 6
Text Book 2: Ch. 13
Text Book 3: Ch. 6

Module – 5	**06 Hrs**

Emerging Geospatial Technologies:

GNSS/GPS/DGPS surveys, LiDAR (airborne/mobile), UAV/drone RS, Photogrammetry (SfM), 3D city modeling, BIM-GIS integration. Web-GIS, cloud (Google Earth Engine), AI/ML in geospatial (CNN for classification), Big Data handling.

Text Book 1: Ch. 8
Text Book 2: Ch. 18
Text Book 3: Ch. 8

Course Outcomes: After completing the course, the students will be able to	
CO1	Analyze electromagnetic spectrum interactions and sensor data for feature extraction in civil engineering applications like land use mapping.
CO2	Evaluate advanced satellite missions and hyperspectral/multispectral data processing techniques for infrastructure monitoring.
CO3	Analyze raster and vector data models, spatial analysis operations, and database management in GIS for civil projects.
CO4	Create geospatial models integrating RS and GIS data for applications in hydrology, transportation, and urban planning.
CO5	Evaluate GNSS/GPS, LiDAR, Photogrammetry, 3D modeling, and RS-GIS with AI/ML for sustainable infrastructure.

Text Books	
1	Thomas M. Lillesand, Ralph W. Kiefer and Jonathan W. Chipman, Remote Sensing and Image Interpretation, John Wiley & Sons, 7th Edition, 2015, ISBN 978-1-118-34328-9. Wiley confirms the 7th edition and 2015 publication; the print ISBN is 978-1-118-34328-9. Wiley-VCH
2	Kang-tsung Chang, Introduction to Geographic Information Systems, McGraw-Hill Education, 9th Edition, 2019, ISBN 978-1-260-09258-5. The uploaded syllabus states 10th Edition/2020, but the publisher and current bibliographic sources verify the 9th Edition as the latest identifiable edition. McGraw Hill
3	Indian Institute of Remote Sensing (IIRS), ISRO, Overview of Remote Sensing & GIS Applications, IIRS, ISRO, Latest Edition: Not applicable (E-Book), 2023, ISBN: Not assigned. The official IIRS source identifies it as a 2023 educational e-book.

Reference Books	
1	Peter A. Burrough, Rachael A. McDonnell and Christopher D. Lloyd, Principles of Geographical Information Systems, Oxford University Press, 3rd Edition, 2015, ISBN 978-0-19-874284-5. WorldCat
2	R. P. Gupta, Remote Sensing Geology, Springer, Latest Edition: 2nd Edition, 2018, ISBN: 978-3-662-55859-0.
3	Paul A. Longley, Michael F. Goodchild, David J. Maguire and David W. Rhind, Geographic Information Science & Systems, Wiley, 4th Edition, 2015, ISBN 978-1-118-67695-0.

Web links and Video Lectures (e–Resources)	
1	**ISRO NRSC: https://www.nrsc.gov.in**
2	**Bhuvan Portal: https://bhuvan.nrsc.gov.in**
3	**NPTEL RS-GIS: https://nptel.ac.in**
4	**QGIS Tutorials: https://www.qgistutorials.com**

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	**Activity A – Thematic RS–GIS project:** Students select a theme (e.g., LULC change, urban expansion, flood mapping) for a chosen study area, perform data acquisition, preprocessing, classification, and map preparation; submit a technical report and maps.	24
	OR	
2	**Activity B – Geospatial database and spatial analysis exercise:** Students design a geospatial database for an engineering application (e.g., urban utilities, transportation, watershed), perform spatial analysis (buffer, overlay, network/terrain analysis) and present results using maps and dashboards.	24
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	Completion of selected NPTEL/MOOC modules on Remote Sensing, GIS, and Web GIS; submission of reflective notes or quiz scores as evidence.	24
	OR	
2	Preparation of technical notes, workflow diagrams, and a digital portfolio demonstrating RS–GIS processing chains for at least two engineering applications.green building rating systems.	24

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3		2	3	
CO2	3	3		3	3	1
CO3	3	3		2	3	
CO4	3	3	3	3	3	2
CO5	3	3	2	2	3	3

Semester: I						
APPLIED STATISTICS & UNCERTAINTY MODELING						
Course Code	**:**	1MCV105B		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50 Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Engineering Mathematics and Basic Statistics
Knowledge on Fundamental Concepts	Basic knowledge of probability, statistics and mathematics
Knowledge on Connected Tools (If any)	Basic knowledge of Excel, Python, MATLAB or R

Course Learning Objectives: This course will enable the students to	
CLO1	Describe probability, random variables and probability distributions used in civil engineering.
CLO2	Apply statistical methods for engineering data analysis and hypothesis testing.
CLO3	Develop regression and ANOVA models for civil engineering applications.
CLO4	Analyze uncertainty and reliability using reliability methods and simulation.
CLO5	Evaluate risk-based decisions using Bayesian methods and decision analysis.

Module – 1	**08 Hrs**

Fundamentals of Probability and Random Variables:

Review of set theory, axioms of probability, conditional probability, law of total probability, Bayes' theorem. **Random variables:** discrete and continuous; probability mass function, probability density function, cumulative distribution function. expectation, variance, covariance,

binomial, Poisson, exponential, normal distributions. selection of problems appropriate distributions for civil engineering data.

Text Book 1: Ch. 2

Text Book 2: Ch. 1

Text Book 3: Ch. 2

Module – 2	**09 Hrs**

Statistical Inference for Engineering Data:

Sampling concepts, sampling distributions, central limit theorem; point and interval estimation. Confidence intervals for means, variances, and proportions; determination of sample size for experiments and field investigations. Hypothesis testing: formulation of null and alternative hypotheses, Type I and Type II errors, p-values, power of a test. Tests on means and variances (t-test, F-test), goodness-of-fit tests (chi-square),.

Applications related to Civil engineering applications: strength testing of concrete and soils, quality control of materials, calibration of empirical factors**.**

Text Book 1: Ch. 5

Text Book 2: Ch. 6

Text Book 3: Ch. 8

Module – 3	**09 Hrs**

Regression, ANOVA, and Multivariate Statistical Methods:

Simple and multiple linear regression: model formulation, estimation of parameters, residual analysis, detection of outliers and influence points. One-way and two-way ANOVA: fixed-effects

models, multiple comparison procedures; applications in mix design and experimental studies. Introduction to multivariate analysis: covariance and correlation matrices, principal component analysis (PCA) for dimensionality reduction.

Civil engineering case studies: prediction of concrete strength, pavement performance models, water demand forecasting, and environmental quality indices.

Text Book 1: Ch. 6
Text Book 2: Ch. 7
Text Book 3: Ch. 12

Module – 4	**08 Hrs**

Reliability Analysis and Uncertainty Propagation:
Concept of reliability and risk in engineering design; safety factor versus reliability-based design. Limit state functions, failure domains, and performance functions for structural and geotechnical systems. Reliability indices (Hasofer–Lind), first-order reliability method (FORM) and second-order reliability method (SORM) – basic ideas and engineering interpretation. Monte Carlo simulation: random sampling, variance reduction (brief overview); estimation of probability of failure and reliability.

Applications: reliability of beams, foundations, retaining structures, slope stability, hydraulic structures, and environmental systems.

Text Book 1: Ch. 8
Text Book 2: Ch. 9
Text Book 3: Ch. 14

Module – 5	**08 Hrs**

Bayesian Methods, Decision Analysis, and Advanced Topics
Bayesian probability: prior, likelihood, posterior; Bayesian updating of model parameters using monitoring data. Decision analysis under uncertainty: decision trees, payoff tables, expected value and expected utility; value of information. Risk-based design and management: risk matrices, societal and individual risk, ALARP concept; performance-based and resilience-based approaches. Time-variant reliability concepts (overview), Markov chains and stochastic processes (introductory ideas) for deterioration modelling.

Integrated case studies: risk-informed decision making for flood management, urban drainage, traffic safety, and lifecycle cost analysis of infrastructure.

Text Book 1: Ch. 9
Text Book 2: Ch. 10
Text Book 3: Ch. 16

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply probability and probability distributions to civil engineering problems.
CO2	Analyze engineering data using statistics and hypothesis testing.
CO3	Develop statistical models for prediction in civil engineering.
CO4	Quantify uncertainty and assess safety using reliability methods.
CO5	Solve risk-based decision problems using Bayesian methods and decision trees, and recommend safe and sustainable infrastructure solutions.

Text Books	
1	Achintya Haldar and Sankaran Mahadevan, Probability, Reliability and Statistical

	Methods in Engineering Design, Wiley,1st Edition, 1999, ISBN 978-0-471-33119-3.
2	Alfredo H.-S. Ang and Wilson H. Tang, Probability Concepts in Engineering: Emphasis on Applications to Civil and Environmental Engineering, Wiley, 2nd Edition, 2006, ISBN 978-0-471-72064-5.
3	Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, Wiley, 7th Edition, 2018, ISBN 978-1-119-40036-3. Wiley lists the 7th edition.
4	Robert E. Melchers and André T. Beck, Structural Reliability Analysis and Prediction, Wiley, 3rd Edition, 2017, ISBN 978-1-119-26599-3.
5	Jack R. Benjamin and C. Allin Cornell, Probability, Statistics, and Decision for Civil Engineers, Dover Publications, Reprint Edition, 2014, ISBN 978-0-486-78072-6.
6	K. Muralidharan and A. Syamsundar, Statistical Methods for Quality, Reliability and Maintainability, PHI Learning, 1st Edition, 2012, ISBN 978-81-203-4543-0.
7	Supreet Singh Bahga, Experimental Uncertainty Analysis: A Textbook for Science and Engineering Students, White Falcon Publishing, 1st Edition, 2021, ISBN 978-1-63640-232-1.
8	V. N. Maurya, A. K. Maurya and Diwinder Kaur Arora, Elements of Advanced Probability Theory and Statistical Techniques, Scholar's Press Publishing Co., 1st Edition, 2014, ISBN 978-3-639-51849-8.

Reference Books	
1	Bilal M. Ayyub and Richard H. McCuen, Probability, Statistics, and Reliability for Engineers and Scientists, CRC Press, 4th Edition, 2025, ISBN 978-1-032-96771-4. Routledge
2	Michael Havbro Faber, Statistics and Probability Theory: In Pursuit of Engineering Decision Support, Springer, 1st Edition, 2012, ISBN 978-94-007-4055-6

Web links and Video Lectures (e–Resources)	
1	NPTEL: Probability and Statistics for Engineers, Risk and Reliability of Offshore Structures, and Uncertainty and Reliability Analysis of Structures (IITs).
2	NPTEL / SWAYAM courses on Applied Multivariate Statistical Modeling, Data Analytics for Civil Engineering, and related topics.
3	Coursera / edX: Courses on Statistical Inference, Bayesian Statistics, and Uncertainty Quantification from
4	R, Python (SciPy, NumPy, pandas, PyMC) and MATLAB tutorials for statistical analysis, regression, and Monte Carlo simulation.
5	Public civil engineering datasets (e.g., concrete strength, traffic, hydrological and environmental data) from Kaggle, government open-data portals, and research repositories

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	**Statistical characterization of engineering data:** Collect or use provided datasets (e.g., concrete strength, rainfall, traffic flow). Perform descriptive statistics, distribution fitting, and hypothesis tests.	24
	OR	
2	**Regression and ANOVA mini-project:** Develop regression/ANOVA models for a chosen civil engineering problem (e.g., pavement performance, settlement prediction).	24

	Evaluate model adequacy and prepare a short technical report.	
	OR	
3	**Reliability and Monte Carlo case study:** Formulate a limit state function for a structural or geotechnical component. Implement Monte Carlo simulation and estimate probability of failure and reliability index.	24
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	Completion of selected NPTEL / MOOC modules on probability, statistics, or reliability and submission of reflective summaries or concept maps	24
	OR	
2	Independent implementation in R/Python/MATLAB of at least two methods: Regression/ANOVA, Monte Carlo simulation, FORM/SORM (basic), or Bayesian updating, with documentation and result interpretation	24

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3		2	2	
CO2	3	3		3	2	
CO3	3	3	3	3	3	
CO4	3	3	3	3	3	2
CO5	3	3	3	3	3	3

Semester: I						
CLIMATE CHANGE MODELING & DISASTER RISK REDUCTION						
Course Code	**:**	1MCV105C		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50 Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Environmental Studies and Disaster Management
Knowledge on Fundamental Concepts	Basic knowledge of climate, weather, environment and natural hazards
Knowledge on Connected Tools (If any)	Basic knowledge of Excel, GIS and data analysis tools

Course Learning Objectives: This course will enable the students to	
CLO1	Describe the climate system, climate change drivers and greenhouse effect.
CLO2	Apply statistical methods to analyze climate data, trends and extreme events.
CLO3	Develop basic climate models and interpret climate projections.
CLO4	Analyze hazard, vulnerability, exposure and disaster risk.
CL05	Evaluate climate risks and apply disaster risk reduction, adaptation and resilience strategies.

Module – 1	**08 Hrs**

Climate System and Climate Change Fundamentals:

- Climate system components, atmosphere, hydrosphere, cryosphere, biosphere, and lithosphere.
- Weather, climate, climate variability, and climate change; natural and anthropogenic drivers.
- Greenhouse effect, carbon cycle, radiative forcing, aerosols, and feedback mechanisms.
- Observed trends in temperature, precipitation, sea level, glacier retreat, and extreme events.
- Introduction to climate indicators and global climate assessment reports.

Text Book 1: Ch. 1
Text Book 2: Ch. 1
Text Book 3: Ch. 1.01

Module – 2	**09 Hrs**

Climate Data Analysis and Trend Detection:

- Sources of climate data: observations, reanalysis products, satellites, and station records.
- Data preprocessing, quality control, missing data handling, and anomaly calculation.
- Descriptive statistics, moving averages, variability measures, and trend analysis.
- Extreme value concepts, return period, and basic analysis of droughts, floods, and heatwaves.
- Statistical tools for climate interpretation using graphs, indices, and time-series summaries.

Text Book 1: Ch. 2
Text Book 2: Ch. 4
Text Book 3: Ch. 5.03

Module – 3	09 Hrs

Climate Change Modeling:

- Introduction to climate models: conceptual, statistical, and process-based models.
- Energy balance models, simple greenhouse models, and scenario-based projections.
- General circulation models and regional climate models: structure and outputs.
- Emission scenarios, uncertainty, model validation, and interpretation of projections.
- Applications of climate models in water resources, agriculture, urban systems, and infrastructure planning.

Text Book 1: Ch. 3
Text Book 2: Ch. 5
Text Book 3: Ch. 3.01

Module – 4	08 Hrs

Hazard, Vulnerability, and Risk Assessment:

- Concepts of hazard, exposure, vulnerability, capacity, and risk.
- Disaster types: hydro-meteorological, geophysical, climatological, and biological hazards.
- Risk assessment frameworks, risk mapping, and multi-criteria prioritization.
- Vulnerability assessment of people, infrastructure, ecosystems, and services.
- Sectoral risk examples: floods, landslides, cyclones, droughts, coastal inundation, and urban heat stress.

Text Book 1: Ch. 4
Text Book 2: Ch. 7
Text Book 3: Ch. 1.03

Module – 5	08 Hrs

Disaster Risk Reduction, Adaptation, and Resilience:

- Disaster risk reduction concepts, prevention, preparedness, response, and recovery.
- Mitigation and adaptation strategies for climate-resilient development.
- Structural and non-structural measures, early warning systems, and evacuation planning.
- Community-based disaster risk reduction, institutional frameworks, and policy instruments.
- Resilience, climate justice, sustainable development, and integrated risk-informed planning.

Text Book 1: Ch. 5
Text Book 2: Ch. 10
Text Book 3: Ch. 5.06

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the fundamentals of climate system, climate variability, and climate change drivers.
CO2	Analyze climate data and identify trends, extremes, and anomalies relevant to hazard assessment.
CO3	Develop basic climate change models and interpret simulation outputs for engineering and environmental applications.

CO4	Assess vulnerability, exposure, and risk for selected natural hazards using appropriate frameworks.
CO5	Apply disaster risk reduction, mitigation, adaptation, and resilience strategies to evaluate climate risks and propose sustainable interventions.

Text Books	
1	Intergovernmental Panel on Climate Change (IPCC), Climate Change 2023: Synthesis Report, IPCC, Latest Assessment Report – AR6, 2023.
2	John Theodore Houghton, Global Warming: The Complete Briefing, Cambridge University Press, 5th Edition, 2015, ISBN 978-1-107-66418-1.
3	Roger A. Pielke Sr. (Editor), Climate Vulnerability: Understanding and Addressing Threats to Essential Resources, Elsevier, 1st Edition, 2013, ISBN 978-0-12-384703-4.
4	P. K. Das, Climate Change and Disaster Management, McGraw Hill.

Reference Books	
1	M. C. Lemos et al., Climate Risk and Resilience, Springer.
2	C. D. Lee and N. J. Singh, Disaster Risk Reduction and Management.
3	Richard W. Katz et al., Statistics of Extremes in Climate and Weather.
4	Keith J. Beven, Rainfall-Runoff Modelling: The Primer, Wiley-Blackwell, 2nd Edition, 2012, ISBN 978-0-470-71459-1.
5	Bruce C. Bates, Zbigniew W. Kundzewicz, Shaohong Wu and John P. Palutikof (Eds.), Climate Change and Water, IPCC, 1st Edition, 2008.

Web links and Video Lectures (e–Resources)	
1	IPCC reports and summaries for policymakers.
2	NDMA and SDMA guidelines on disaster risk reduction.
3	IMD climate and weather datasets and climate services.
4	NASA Earthdata and Copernicus Climate Data Store.
5	NPTEL/SWAYAM courses on climate change, hydrology, hazard assessment, and disaster management.

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	**Climate data analysis exercise:** Analyze temperature or rainfall data, compute trends, anomalies, and variability metrics.	24
	OR	
2	**Climate impact case study:** Prepare a case study on flood, drought, cyclone, or heatwave risk for a chosen region.	24
	OR	
3	**Risk assessment and mapping assignment:** Develop a simple hazard-vulnerability-risk matrix for a local community or infrastructure asset.	24
	OR	
4	**Adaptation plan mini-project:** Propose adaptation and resilience measures for an urban, coastal, or agricultural system.	24

SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	Read selected IPCC summary sections and prepare a reflective note.	24
	OR	
2	Develop a concept map on risk, vulnerability, and resilience.	24
	OR	
3	Complete a MOOC module on climate change or disaster risk reduction.	24

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2		2		2
CO2	3	3		3	2	2
CO3	3	3	2	3	3	2
CO4	3	3	3	3	2	3
CO5	3	3	3	3	2	3

Semester: I						
SUSTAINABLE MATERIALS & CIRCULAR ECONOMY						
Course Code	**:**	1MCV105D		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50 Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Environmental Studies, Building Materials
Knowledge on Fundamental Concepts	Basic knowledge of sustainability, construction materials, environment
Knowledge on Connected Tools (If any)	Basic knowledge of Excel, LCA tools and online sustainability resources.

Course Learning Objectives: This course will enable the students to	
CLO1	Describe sustainability, circular economy principles and resource efficiency in civil engineering.
CLO2	Apply sustainable material concepts and low-carbon construction practices.
CLO3	Analyze life-cycle impacts, carbon footprint and environmental performance of construction materials.
CLO4	Develop circular strategies for reuse, recycling, waste reduction and material recovery.
CLO5	Evaluate sustainable materials and circular construction solutions for civil engineering projects.

Module – 1	**08 Hrs**
Sustainability and Circular Economy Basics: Introduction to sustainability, SDGs, resource depletion, environmental footprints, circular economy principles, linear-to-circular transition, systems thinking, product life cycle, material loops, urban mining, and circularity in the built environment. Overview of civil engineering relevance in planning, materials selection, and infrastructure development. **Text Book 1:** Ch. 1 **Text Book 2:** Ch. 1	
Module – 2	**10 Hrs**
Sustainable Construction Materials: Conventional and alternative construction materials, embodied energy, embodied carbon, low-carbon cementitious systems, supplementary cementitious materials, recycled aggregates, industrial by-products, geopolymer concrete, sustainable steel, timber, bamboo, earth-based materials, recycled plastics, and bio-based materials. Performance, durability, and serviceability considerations in civil engineering applications. **Text Book 1:** Ch. 4 **Text Book 2:** Ch. 2	
Module – 3	**10 Hrs**
Life-Cycle Thinking and Environmental Assessment: Life-cycle assessment, life-cycle costing, material flow analysis, carbon footprint estimation, water footprint, environmental product declarations, selection criteria for sustainable materials, durability and maintenance impacts, circular performance indicators, and interpretation of environmental metrics. Basic tools and spreadsheet-based assessment methods for material evaluation. **Text Book 1:** Ch. 5 **Text Book 2:** Ch. 3	

Module – 4	08 Hrs

Circular Design, Reuse, and Waste Management:

Design for reuse, repair, refurbishment, remanufacturing, and disassembly; modular construction; prefabrication; construction and demolition waste management; source segregation; recovery pathways; recycling processes; material passports; reverse logistics; and circular planning for buildings and infrastructure. Strategies for reducing waste during construction, operation, renovation, and demolition.

Text Book 1: Ch. 14
Text Book 2: Ch. 4

Module – 5	08 Hrs

Policy, Case Studies, and Project Applications:

Circular economy policies, green procurement, standards and codes, incentive mechanisms, extended producer responsibility, carbon regulation trends, institutional frameworks, and implementation barriers. Integrated case studies on sustainable buildings, pavement materials, infrastructure reuse, waste-to-resource systems, and campus-scale circularity planning.

Text Book 1: Ch. 15
Text Book 2: Ch. 8

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain sustainability, resource efficiency, and circular economy concepts in civil engineering.
CO2	Analyze environmental impacts, carbon emissions, and life-cycle performance of construction materials.
CO3	Evaluate sustainable, recycled, and low-carbon materials based on performance and durability.
CO4	Design circular material strategies using reuse, recycling, redesign, and waste reduction.
CO5	Assess circular construction strategies and develop sustainable material solutions for civil engineering projects.

Text Books	
1	Charles J. Kibert, Sustainable Construction: Green Building Design and Delivery, John Wiley & Sons, 5th Edition, 2022, ISBN 978-1-119-70645-8.
2	Author not specified, Cradle to Cradle-inspired and Circular Economy Texts on Built Environment Sustainability.
3	William McDonough and Michael Braungart, Cradle to Cradle: Remaking the Way We Make Things, North Point Press, 1st Edition, 2002, ISBN 978-0-86547-587-8.
4	Paul T. Anastas and Julie B. Zimmerman, Design through the Twelve Principles of Green Engineering, American Chemical Society, 2003.

Reference Books	
1	Ghisellini, P., Ripa, M., and Ulgiati, S., "Exploring Environmental and Economic Costs and Benefits of a Circular Economy Approach to the Construction and Demolition Sector: A Literature Review," Elsevier, Journal of Cleaner Production, 2018, Volume 178, pp. 618–643, DOI: 10.1016/j.jclepro.2017.11.207.
2	Ashby, M. F., Materials and the Environment: Eco-informed Material Choice, Elsevier/Butterworth-Heinemann, 2nd Edition, 2012, ISBN 978-0-12-385971-6.
3	Allen, E. and Iano, J., Fundamentals of Building Construction: Materials and Methods, John Wiley & Sons, 8th Edition, 2025, ISBN 978-1-394-22012-0. Wiley-VCH
4	Allen, E. and Iano, J. Fundamentals of Building Construction: Materials and Methods with sustainability add-ons

Web links and Video Lectures (e–Resources)	
1	Ellen MacArthur Foundation resources on circular economy.
2	IPCC and UNEP resources on embodied carbon and materials.
3	NPTEL courses on sustainable construction materials and circular economy.
4	UN-Habitat, World Green Building Council, and C&D waste guidance documents.

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	Mini project: Material circularity plan for a civil engineering project	24
	OR	
2	Case Study: Sustainable Building Materials Case Study	24
	OR	
3	Field Visit: Visit to recycling facility/green construction site	24
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	Analyze LEED/GRIHA certified building materials	24
	OR	
2	Design poster on "Circular Economy in Infrastructure"	24
	OR	
3	Complete a MOOC module on Sustainable Building Materials	24

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2				3
CO2	3	3	2	2	2	3
CO3	3	3	2	3	3	3
CO4	3	3	3	2	3	3
CO5	3	3	3	3	3	3

Semester: I						
PROJECT FEASIBILITY AND REPORT WRITING						
Course Code	**:**	1MCV105E		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50 Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50 Marks
Course Type	**:**	PCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Project Management, Engineering Economics
Knowledge on Fundamental Concepts	Basic knowledge of project planning, costing, finance, risk and technical communication
Knowledge on Connected Tools (If any)	Basic knowledge of Excel, project management software and presentation tools

Course Learning Objectives: This course will enable the students to	
CLO1	Describe project identification, project life cycle and feasibility concepts.
CLO2	Analyze technical, market, economic and financial feasibility of projects.
CLO3	Apply cost estimation, project appraisal and risk analysis methods.
CLO4	Develop a Detailed Project Report (DPR) using appropriate standards and guidelines.
CLO5	Evaluate technical reports considering sustainability, safety and stakeholder requirements.

Module – 1	**08 Hrs**

Introduction to Projects and Feasibility:

- Definitions and characteristics of projects; project cycle; types of projects in civil, infrastructure, transportation, water resources, building, and environmental sectors.
- Project identification, screening of project ideas, preliminary studies, pre-feasibility vs detailed feasibility.
- Role of stakeholders, sponsors, consultants, and regulatory bodies in project formulation.
- Overview of project feasibility dimensions: technical, market, financial, economic, environmental, social, legal, and institutional.

Text Book 1: Ch. 1

Text Book 2: Ch. 1

Text Book 3: Ch. 1

Module – 2	**08 Hrs**

Technical, Market, and Economic Feasibility:

- Technical feasibility: site selection, technology choice, capacity planning, design standards, resource availability, and infrastructure support.
- Market feasibility: demand and supply analysis for infrastructure services, stakeholder needs assessment, service level benchmarks, pricing considerations.
- Economic feasibility: cost–benefit analysis, economic internal rate of return (EIRR), evaluation of tangible and intangible benefits.
- Case illustrations of feasibility assessment for typical urban infrastructure and construction projects.

Text Book 1: Ch. 2

Text Book 2: Ch. 2
Text Book 3: Ch. 2

Module – 3	09 Hrs

Financial Analysis and Risk Assessment:

- Financial feasibility: project cost components, capital and operating costs, working capital, life-cycle costing.
- Time value of money: compounding, discounting, annuities, depreciation basics (conceptual coverage).
  Project appraisal criteria: net present value (NPV), internal rate of return (IRR), benefit–cost ratio (BCR), payback period, sensitivity analysis.
- Risk and uncertainty in projects: identification of risks, risk classification, qualitative and quantitative risk analysis approaches; risk mitigation strategies.

Text Book 1: Ch. 3
Text Book 2: Ch. 4
Text Book 3: Ch. 5

Module – 4	09 Hrs

Detailed Project Report (DPR) – Structure and Preparation:

- Purpose and components of a DPR for infrastructure and civil engineering projects.
- Typical DPR structure: executive summary, background and need, objectives, project description and scope, technical details, implementation schedule, cost estimates, financial and economic analysis, environmental and social aspects, risk assessment, institutional arrangements.
- Alignment of DPR with statutory requirements (e.g., environmental clearances, urban development regulations), funding agency formats, and government guidelines (where applicable).
- Use of digital tools (spreadsheets, project management software, templates) for DPR preparation and documentation.

Text Book 1: Ch. 6
Text Book 2: Ch. 7
Text Book 3: Ch. 8

Module – 5	08 Hrs

Technical Report Writing and Presentation:

- Fundamentals of technical writing: clarity, coherence, objectivity, and ethical practices.
- Structure of technical reports: introduction, literature/context review, methodology, results, discussion, conclusions, recommendations, references, and annexures.
- Writing style for project reports: use of figures, tables, charts, drawings, and appendices; citation and referencing norms; plagiarism awareness.
- Preparation of presentations based on DPRs: slide design, visualization of project data, pitching to technical and non-technical audiences; group presentation and peer feedback.

Text Book 1: Ch. 9
Text Book 2: Ch. 10
Text Book 3: Ch. 11

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain project life cycle, identification, formulation, and feasibility of civil engineering projects.

CO2	Analyze technical, financial, economic, environmental, and social aspects of project feasibility.
CO3	Apply methods for project cost estimation, risk analysis, and project appraisal.
CO4	Prepare a Detailed Project Report (DPR) as per required standards.
CO5	Integrate technical communication, sustainability, safety, and stakeholder aspects in project feasibility and reporting.

Text Books	
1	Prasanna Chandra, Projects: Planning, Analysis, Selection, Financing, Implementation, and Review, McGraw Hill Education (India) Private Limited, 10th Edition, 2023, ISBN 9789355324993.
2	K. Nagarajan, Project Management, New Age International, 8th Edition, 2020, ISBN 9789386286024.
3	S. Choudhury, Project Management, McGraw Hill Education, 1st Edition, 2014, ISBN 9780074600689.
4	R. Panneerselvam, Engineering Economics, PHI Learning, 2nd Edition, 2013, ISBN 9788120348370.
5	M. E. Van Valkenburg, Network Analysis, PHI Learning, 3rd Edition, 2009, ISBN 9788120301566.

Reference Books	
1	Guidelines/manuals of national agencies (e.g., CPWD, NHAI, MoRTH, MoHUA, CPHEEO) on preparation of DPRs for infrastructure projects, latest editions.
2	Model DPRs and feasibility reports from government and international agencies (World Bank, ADB, etc.) for civil and infrastructure projects.
3	BIS and IRC codes relevant to cost estimation, planning, and design of civil works (selected provisions).
4	Institutional / state-level project appraisal guidelines and formats, where applicable.

Web links and Video Lectures (e–Resources)	
1	NPTEL / SWAYAM courses on project management, infrastructure financing, engineering economics, and technical communication.
2	Government portals hosting DPR templates, standard bidding documents, and appraisal guidelines for infrastructure projects.
3	Open educational resources and case repositories on project feasibility studies and report writing for civil and infrastructure projects.

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	**Project idea screening note** • Students identify 2–3 project ideas and justify the best one using basic feasibility criteria. • Output: 2–3 page note with problem statement, need, and preliminary feasibility.	24
	OR	
2	**Feasibility matrix** • Students prepare a comparison matrix covering technical, financial, environmental, social, and institutional feasibility. • Output: weighted matrix with brief justification for each criterion.	24

	OR	
3	**DPR section writing** • Students draft selected DPR sections such as executive summary, project background, objectives, scope, and implementation plan. • Output: structured report in formal format.	24
	OR	
4	**Cost and risk analysis sheet** • Students estimate project cost heads and identify key risks with mitigation measures.	24
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	**Seminar on feasibility study** Each student presents one feasibility dimension, such as technical, financial, or environmental feasibility.	24
	OR	
2	**Case presentation on a real project** Students present a real infrastructure project and explain why it is feasible or not.	24
	OR	
3	**DPR pitch presentation** Students present their project proposal, emphasizing need, scope,cost, and impact.	24

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2				2
CO2	3	3	2	2		2
CO3	3	3	3	3	2	2
CO4	3	3	3	2	3	2
CO5	3	3	3	3	3	3

Semester: I						
SUSTAINABLE INFRASTRUCTURE PLANNING & POLICY						
Course Code	**:**	1MCV105F		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Environmental Studies, Infrastructure Planning
Knowledge on Fundamental Concepts	Basic knowledge of sustainability, infrastructure, planning and environmental impacts.
Knowledge on Connected Tools (If any)	Basic knowledge of GIS, BIM, Excel and planning tools

Course Learning Objectives:	
CLO1	Describe sustainability concepts, infrastructure life cycle and sustainable planning principles.
CLO2	Apply sustainability assessment and planning tools for infrastructure projects.
CLO3	Analyze sustainable infrastructure design strategies and resilience measures.
CLO4	Evaluate policies, governance, regulations and financing approaches for sustainable infrastructure.
CLO5	Develop sustainable infrastructure solutions considering policy, resources, climate and community needs.

Module – 1	**08Hrs**
Introduction to Sustainable Infrastructure Planning: Concept of sustainable infrastructure, infrastructure life cycle, systems thinking, SDGs, resource efficiency, climate-responsive planning, urbanization challenges, and relationship between infrastructure, environment, and society. Overview of transportation, water, sanitation, energy, waste, and public infrastructure systems in the sustainability context. **Text Book 1:** Ch. 1 **Text Book 2:** Ch. 2 **Text Book 3:** Ch. 2	
Module – 2	**10Hrs**
Infrastructure Assessment and Planning Tools: Sustainability assessment frameworks, environmental impact assessment, social impact assessment, economic appraisal, multi-criteria decision analysis, resilience assessment, risk-based planning, carbon and water footprint concepts, and life-cycle thinking in infrastructure planning. Data-based planning tools, indicators, and decision-support methods. **Text Book 1:** Ch. 4 **Text Book 2:** Ch. 3 **Text Book 3:** Ch. 10	
Module – 3	**10Hrs**
Sustainable Infrastructure Design Strategies: Green infrastructure, nature-based solutions, low-impact development, climate adaptation, demand management, energy-efficient systems, water-sensitive urban design, inclusive design, universal accessibility, and resource-efficient infrastructure design. Role of digital tools, BIM, GIS, and smart infrastructure in sustainable planning. **Text Book 1:** Ch. 8	

Text Book 2: Ch. 6
Text Book 3: Ch. 16

Module – 4	08 Hrs

Policy, Governance, and Finance:
National and international sustainability policies, urban and infrastructure policy frameworks, regulatory mechanisms, standards and codes, public-private partnerships, green procurement, climate policy, incentives, financing models, institutional roles, and governance challenges in implementation. Integration of policy with planning, monitoring, and compliance**.**

Text Book 1: Ch. 15
Text Book 2: Ch. 6
Text Book 3: Ch. 16

Module – 5	06 Hrs

Case Studies and Project Applications:

Case studies on sustainable transport systems, water supply and sanitation planning, resilient urban drainage, solid waste infrastructure, energy-efficient public facilities, and climate-resilient community infrastructure. Project-based applications for campus, town, and city-scale sustainable infrastructure planning with policy alignment and stakeholder engagement.

Text Book 1: Ch. 16
Text Book 2: Ch. 6
Text Book 3: Ch. 16

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain sustainability concepts, infrastructure life cycle, and policies for sustainable civil engineering systems.
CO2	Analyze environmental, social, economic, and governance impacts of infrastructure projects.
CO3	Evaluate planning alternatives, technologies, and standards for sustainable and resilient infrastructure.
CO4	Design sustainable infrastructure strategies using circularity, climate adaptation, and resource efficiency.
CO5	Assess policies and regulations and develop sustainable infrastructure solutions for community needs.

Text Books	
1	Charles J. Kibert, Sustainable Construction: Green Building Design and Delivery, John Wiley & Sons, 5th Edition, 2022, ISBN 978-1-119-70645-8. Wiley-VCH
2	William McDonough and Michael Braungart, Cradle to Cradle: Remaking the Way We Make Things, North Point Press, 1st Edition, 2002, ISBN 978-0-86547-587-8. Macmillan Academic
3	Larry W. Mays, Water Resources Engineering, John Wiley & Sons, 3rd Edition, 2024, ISBN 978-1-119-49057-9. Wiley-VCH
4	Peter Newman and Isabella Jennings, Cities as Sustainable Ecosystems: Principles and Practices, Island Press, Revised Edition, 2012, ISBN 978-1-59726-747-2. Google Books

Reference Books	
1	Michael F. Ashby, Materials and the Environment: Eco-informed Material Choice, Elsevier/Butterworth-Heinemann, 3rd Edition, 2021, ISBN 978-0-12-821521-0.
2	Richard Rogers, Cities for a Small Planet, Westview Press, New Edition, 1998, ISBN 978-0-8133-3553-7.
3	William R. Black, Sustainable Transportation: Problems and Solutions, Guilford Press, 1st Edition, 2010, ISBN 978-1-60623-485-3.
4	UN-Habitat and World Bank, Reports on Sustainable Infrastructure Planning, respective latest editions, UN-Habitat/World Bank.

Web links and Video Lectures (e–Resources)	
1	World Bank sustainable infrastructure resources.
2	UN-Habitat urban sustainability and resilience resources.
3	IPCC reports on climate adaptation and infrastructure.
4	NPTEL courses on sustainable infrastructure, urban planning, and policy.

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	Sustainable infrastructure case study analysis	24
	OR	
2	Campus infrastructure sustainability audit	24
	OR	
3	Mini project on resilient infrastructure planning	
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	Analyze sustainability policy of an urban infrastructure project	24
	OR	
2	Prepare a comparative report on green infrastructure strategies	24
	OR	
3	Complete a MOOC module on sustainable infrastructure planning	24

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2				3
CO2	3	3		3	2	3
CO3	3	3	3	2	3	3
CO4	3	3	3	2	3	3
CO5	3	3	3	3	3	3

Semester: I						
OCCUPATIONAL HEALTH AND SAFETY ENGINEERING						
Course Code	**:**	1MCV105G		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Environmental Studies, Construction Engineering
Knowledge on Fundamental Concepts	Basic knowledge of occupational health, safety, hazards and risk
Knowledge on Connected Tools (If any)	Basic knowledge of Excel, safety assessment and documentation tools

Course Learning Objectives:	
CLO1	Describe occupational health hazards, exposure limits and ergonomic principles.
CLO2	Apply hazard identification, risk assessment and safety management techniques.
CLO3	Analyze fire, electrical, machine and emergency safety practices.
CLO4	Develop safety plans, PPE strategies and inspection procedures for construction sites.
CLO5	Evaluate safety performance, legal requirements and safety management practices.

Module – 1	**08Hrs**

Fundamentals of Occupational Health:

Introduction to occupational health and safety, historical development, importance of safety in engineering practice, occupational health hazards, routes of entry of toxic substances into the human body, permissible exposure limits, threshold limit value, acute and chronic exposure, occupational diseases caused by dusts, fumes, gases, metals, and chemicals. Ergonomics: principles, workplace design, fatigue, posture, manual handling, and preventive measures**.**

Text Book 1: Ch. 1
Text Book 2: Ch. 1
Text Book 3: Ch. 1

Module – 2	**10Hrs**

Safety Management and Hazard Control:

Safety concepts and principles, accident causation theories, incident reporting, accident investigation, hazard identification, risk assessment, job safety analysis, safe work procedures, hierarchy of controls, safety signage, behavioral safety, and emergency preparedness. Introduction to industrial hygiene and control measures for physical, chemical, biological, and mechanical hazards.

Text Book 1: Ch. 2
Text Book 2: Ch. 3
Text Book 3: Ch. 2

Module – 3	**10Hrs**

Fire, Electrical and Machine Safety:

Fire triangle, causes and classes of fire, fire detection and suppression systems, fire extinguishers, evacuation planning, and emergency drills. Electrical safety: shock hazards, grounding, insulation, lockout-tagout principles, safe use of electrical equipment. Machine safety: guards, interlocks, safe operating procedures, and common causes of equipment-related accidents.

Text Book 1: Ch. 4
Text Book 2: Ch. 5
Text Book 3: Ch. 4

Module – 4	08 Hrs

Construction Site Safety and PPE:

Safety in construction sites, excavation safety, scaffolding safety, lifting operations, formwork safety, working at heights, confined space safety, and material handling. Personal protective equipment: selection, use, limitations, maintenance, and training. Safety documentation: permit-to-work, toolbox talks, inspection formats, and site safety.

Text Book 1: Ch. 6
Text Book 2: Ch. 7
Text Book 3: Ch. 6

Module – 5	06 Hrs

Safety Audit, Laws and Emerging Practices:

Occupational safety legislation, statutory provisions, employer and employee responsibilities, safety audit, inspections, monitoring, compliance records, and safety management systems. Introduction to environmental health, sustainability in safety practice, incident metrics, and digital tools for safety monitoring. Case studies from civil engineering, construction, and infrastructure sectors.

Text Book 1: Ch. 8
Text Book 2: Ch. 9
Text Book 3: Ch. 8

Course Outcomes: After completing the course, the students will be able to	
CO1	Analyze workplace health hazards, toxic exposure, ergonomics and disease prevention.
CO2	Analyze workplace safety, accident causes, hazards and risk control methods.
CO3	Evaluate fire, electrical, machine and emergency safety measures.
CO4	Prepare safety plans, inspection checklists and PPE strategies for construction and industrial sites.
CO5	Evaluate occupational safety practices and safety performance in civil engineering projects.

Text Books	
1	A. M. Sarma, Industrial Safety, Health and Environment Management, Khanna Publishers, 1st Edition, 2009, ISBN 978-81-7409-175-8.
2	R. K. Jain and Sunil S. Rao, Industrial Safety, Health and Environment Management Systems, Khanna Publishers.
3	John Ridley, Safety at Work, Butterworth-Heinemann, 8th Edition, 2008, ISBN 978-0-7506-8567-2.
4	Frank R. Spellman and Revonna M. Bieber, Handbook of Safety Principles, Government Institutes, 1st Edition, 2012, ISBN 978-1-60590-762-8.

Reference Books	
1	Relevant provisions of the Factories Act, Building and Other Construction Workers legislation, and allied safety rules.
2	BIS standards related to safety, PPE, scaffolding, fire protection, and electrical safety.
3	ILO guidelines on occupational safety and health.
4	National and international codes of practice for construction safety and health.
5	Case manuals and safety audit checklists from reputed infrastructure and industrial organizations.

Web links and Video Lectures (e–Resources)	
1	NPTEL/SWAYAM courses on industrial safety, occupational health, and risk management.
2	Government portals and regulatory sites providing safety rules, acts, and notifications.
3	Online training modules on fire safety, emergency preparedness, and workplace safety.
4	Open educational resources on risk assessment, HAZOP, and safety audits.

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	**Hazard identification sheet:** Identify hazards in a civil/industrial workplace and classify them as physical, chemical, electrical, mechanical, ergonomic, or fire hazards.	24
	OR	
2	**Risk assessment matrix:** Prepare a risk matrix with likelihood, severity, risk ranking, and control measures for a selected site activity.	24
	OR	
3	**Emergency response plan:** Prepare an emergency evacuation and first-aid response plan for a project site.	24
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	**Seminar on safety laws and standards:** Present one act, rule, code, or standard related to occupational safety and health.	24
	OR	
2	**PPE selection presentation:** Present appropriate PPE for a selected operation, including selection criteria and limitations.	24
	OR	
3	**Safety plan pitch presentation:** Present a site safety plan covering hazards, controls, emergency response, and monitoring.	24

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2		2		3
CO2	3	3	2	3	2	3
CO3	3	3	2	3	3	3
CO4	3	3	3	2	3	3
CO5	3	3	3	3	3	3

Semester: I						
SUSTAINABLE GEO-MECHANICS AND ENGINEERING						
Course Code	**:**	1MCV105H		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Geotechnical Engineering, Engineering Geology
Knowledge on Fundamental Concepts	Basic knowledge of soil properties, compaction, consolidation, shear strength and foundations
Knowledge on Connected Tools (If any)	Basic knowledge of Excel and geotechnical analysis tools

Course Learning Objectives:	
CLO1	Describe soil and rock properties and their role in sustainable geotechnical engineering.
CLO2	Apply soil behavior, compaction, settlement and ground improvement principles.
CLO3	Analyze slope stability, retaining systems and sustainable ground protection methods.
CLO4	Evaluate foundation and underground systems considering safety, durability and resource efficiency.
CLO5	Develop sustainable geotechnical solutions considering environmental risks, resilience and digital tools.

Module – 1	**08Hrs**

Fundamentals of Sustainable Geo-mechanics:

Introduction to geo-mechanics and sustainability in geotechnical engineering, role of geotechnics in infrastructure development, soil formation and mineralogy, phase relationships, index properties, soil classification, engineering behavior of soils and rocks, environmental concerns in geotechnical works, life-cycle thinking in ground engineering, and overview of sustainable materials and practices in geo-engineering.

Text Book 1: Ch. 2
Text Book 2: Ch. 1
Text Book 3: Ch. 2

Module – 2	**10Hrs**

Soil Behavior, Compaction and Ground Improvement:

Stress distribution in soils, permeability and seepage, consolidation and compression characteristics, shear strength parameters, compaction theory and field control, settlement analysis, geosynthetics in sustainable geotechnics, ground improvement methods such as drainage, vibro-compaction, stone columns, and stabilization using eco-friendly additives.

Text Book 1: Ch. 6
Text Book 2: Ch. 4
Text Book 3: Ch. 5

Module – 3	**10Hrs**

Slope Stability and Earth Retaining Systems:

Stability of natural and cut slopes, modes of failure, factor of safety, stability analysis methods, drainage in slopes, reinforced earth, retaining walls, crib walls, gabions, and sustainable slope protection measures, erosion control, bioengineering approaches, and green infrastructure solutions for slope management.

Text Book 1: Ch. 15

Text Book 2: Ch. 12 **Text Book 3:** Ch. 17	
Module – 4	**08 Hrs**
Sustainable Foundations and Underground Works: Shallow and deep foundations, bearing capacity, pile foundations, raft foundations, sustainable design considerations, foundation settlement control, excavation support systems, tunnels and underground openings, groundwater issues, dewatering methods, reuse of excavated material, and low-impact construction practices in foundation engineering**.** **Text Book 1:** Ch. 16 **Text Book 2:** Ch. 8 **Text Book 3:** Ch. 12	
Module – 5	**08 Hrs**
Geo-environmental Risk and Resilient Infrastructure: Geo-environmental impacts of construction, contaminant transport in soils, landfill liners and barriers, waste utilization in geotechnical works, climate-resilient geotechnical design, seismic effects on soils, risk assessment and mitigation, monitoring methods, instrumentation, digital tools in geotechnics, case studies on sustainable infrastructure and disaster-resilient ground engineering. **Text Book 1:** Ch. 17 **Text Book 2:** Ch. 13 **Text Book 3:** Ch. 4	

Course Outcomes: After completing the course, the students will be able to	
CO1	Analyze geotechnical properties of soils and rocks for sustainable engineering applications.
CO2	Analyze slope stability, settlement, and ground improvement needs using environmentally responsible methods.
CO3	Evaluate foundation and earth-retaining systems with emphasis on safety, durability, and resource efficiency.
CO4	Create sustainable solutions for soil stabilization, ground improvement, and site development.
CO5	Evaluate geotechnical risks and environmental impacts and design sustainable geo-engineering strategies for climate-resilient infrastructure.

Text Books	
1	Braja M. Das and Khaled Sobhan, Principles of Geotechnical Engineering, Cengage Learning, 8th Edition, 2014, ISBN 978-1-133-10867-2. Mahindra University Library
2	Jonathan Knappett and R. F. Craig, Craig's Soil Mechanics, CRC Press, 8th Edition, 2012, ISBN 978-0-415-56126-6. University of Dundee Discovery Portal
3	Braja M. Das and Nagaratnam Sivakugan, Principles of Foundation Engineering, Cengage Learning, 9th Edition, 2019, ISBN 978-1-337-70503-5. Cengage Asia
4	C. V. S. Kumar and others, Geotechnical Engineering Practice for Sustainable Infrastructure, McGraw Hill Education, Latest Edition, Year and ISBN not verified from reliable bibliographic sources.
5	P. Purushothama Raj, Ground Improvement Techniques, Laxmi Publications, 2nd Edition, 2016, ISBN 978-81-318-0594-7. KL University Library

Reference Books	
1	Edward Allen and Joseph Iano, Fundamentals of Building Construction: Materials and Methods, Wiley, 7th Edition, 2019, ISBN 978-1-119-44779-5.
2	Michael F. Ashby, Materials and the Environment: Eco-informed Material Choice, Elsevier, 3rd Edition, 2021, ISBN 978-0-12-821521-0.

3	BEP / LCA Guidance Documents on Buildings and Construction Materials.
4	P. Ghisellini, M. Ripa and S. Ulgiati, Works on Circular Economy in Construction.
5	Bureau of Indian Standards, Relevant BIS Codes for Geotechnical Investigation, Foundations, Retaining Structures and Slope Stability, BIS.
6	Federal Highway Administration and Indian Roads Congress, Guidelines on Soil Stabilization, Earth Retaining Structures and Foundations, FHWA/IRC.
7	Manuals on Geosynthetics, Environmental Geotechnics and Slope Protection, ICE Publishing / CRC Press / Springer.
8	Research Reports on Sustainable Ground Improvement and Resilient Geotechnical Design, Elsevier / Springer / ASCE .
9	Case Manuals on Difficult Soil Conditions and Eco-friendly Ground Treatment, reputed technical agencies and institutions..

Web links and Video Lectures (e–Resources)	
1	IIT/NPTEL Geotechnical Engineering: https://nptel.ac.in
2	IRC / Geotechnical guidance resources
3	IS 1498, IS 2720 series, IS 1893, and related BIS standards
4	Ground improvement and sustainable infrastructure lecture resources

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	**Soil sustainability audit:** Assess a site soil condition and suggest eco-friendly geotechnical interventions.	24
	OR	
2	**Ground improvement comparison:** Compare conventional and sustainable ground improvement methods for a selected site.	24
	OR	
3	**Slope stabilization plan:** Prepare a slope protection and erosion control plan using bioengineering measures.	24
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	**Seminar on sustainable geotechnics:** Present a topic on eco-friendly soil improvement or resilient foundation systems.	24
	OR	
2	**Case study presentation**: Present a case study on slope failure, soil contamination, or sustainable ground treatment.	24
	OR	
3	**Mini project pitch:** Present a sustainable geotechnical solution for a selected infrastructure site.	24

CO – PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3		2		3
CO2	3	3	2	3	2	3
CO3	3	3	3	2		3
CO4	3	3	3	2	2	3
CO5	3	3	3	3	3	3

Semester: I						
GEOSPATIAL DATA STANDARD AND POLICY						
Course Code	**:**	1MCV105I		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	GIS and Remote Sensing, Geospatial Data Management
Knowledge on Fundamental Concepts	Basic knowledge of GIS, spatial data, coordinate systems and databases
Knowledge on Connected Tools (If any)	Basic knowledge of GIS software, spatial databases and web-based geospatial tools

Course Learning Objectives:	
CLO1	Describe geospatial data concepts, models, quality and metadata.
CLO2	Apply geospatial standards and interoperability principles for data exchange.
CLO3	Analyze geospatial policies, governance and regulations in India.
CLO4	Evaluate geospatial data sharing, compliance and governance practices.
CLO5	Develop policy-compliant geospatial data strategies for planning and service delivery.

Module – 1	**08Hrs**
Fundamentals of Geospatial Data: Introduction to geospatial information, spatial and non-spatial data, coordinate reference systems, map projections, data types, raster and vector models, spatial resolution, accuracy, precision, completeness, and consistency. Concepts of geospatial data lifecycle, data sources, and typical applications in governance, planning, and engineering. **Text Book 1:** Ch. 1 **Text Book 2:** Ch. 1 **Text Book 3:** Ch. 2	
Module – 2	**10Hrs**
Geospatial Standards and Interoperability: Need for standards in geospatial data management, interoperability, data sharing, and reuse. Overview of metadata standards, data content standards, geodetic reference frameworks, feature catalogues, naming conventions, web services, APIs, and encoding formats. Introduction to ISO-based geospatial standards and their relevance to national data infrastructure. **Text Book 1:** Ch. 3 **Text Book 2:** Ch. 4 **Text Book 3:** Ch. 5	
Module – 3	**10Hrs**
National Geospatial Policy and Governance: Evolution of geospatial policy in India, National Geospatial Policy 2022, key provisions, objectives, and institutional framework. Role of DST, GDPDC, Survey of India, BIS, NSDI, and sectoral agencies. Liberalization of geospatial data access, public data sharing, and the role of academia and industry. Policy directions for national geospatial missions, digital economy, and	

citizen services.
Text Book 1: Ch. 5
Text Book 2: Ch. 6
Text Book 3: Ch. 10

Module – 4	08 Hrs

Geospatial Data Sharing, Registry, and Compliance:
National geospatial data registry, harmonization of datasets, data publishing workflows, compliance requirements, metadata registration, and data governance practices. Concepts of FAIR principles, data security, sensitive data handling, licensing, open data, and institutional data-sharing protocols. Discussion on practical implementation challenges and compliance mechanisms.
Text Book 1: Ch. 6
Text Book 2: Ch. 7
Text Book 3: Ch. 12

Module – 5	08 Hrs

Applications, Case Studies, and Emerging Directions:
Applications of geospatial standards and policy in land records, urban planning, infrastructure development, agriculture, disaster management, utilities, and environmental monitoring. Case studies on national missions and geospatial-enabled programs. Emerging themes such as digital twins, geospatial AI, open geospatial platforms, and sector-specific standards. Student project on policy-compliant geospatial data framework for a chosen application.
Text Book 1: Ch. 8
Text Book 2: Ch. 9
Text Book 3: Ch. 14

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain geospatial data concepts, data models, metadata, and quality requirements.
CO2	Interpret geospatial standards and interoperability requirements for data exchange.
CO3	Analyze India's geospatial policy, governance structure, and enabling regulations.
CO4	Apply standards and policy provisions to geospatial data management and sharing.
CO5	Evaluate geospatial data infrastructure for governance and planning and develop policy-compliant geospatial data strategies for effective service delivery.

Text Books	
1	M. Burnett and others, Geospatial Data Standards and Interoperability, Springer Nature, Latest Edition, Year and ISBN not specified in the given syllabus.
2	Joep Crompvoets and Arjen Bregt, Spatial Data Infrastructure and Geospatial Policy, CRC Press, Latest Edition, Year and ISBN not specified in the given syllabus.
3	Paul A. Longley, Michael F. Goodchild, David J. Maguire and David W. Rhind, Geographic Information Systems and Science, Wiley, 4th Edition, 2015, ISBN 978-1-118-67695-0.
4	Michael Zeiler, Modeling Our World: The ESRI Guide to Geodatabase Concepts, ESRI Press, 2nd Edition, 2010, ISBN 978-1-58948-278-1.
Reference Books	
1	Abbas Rajabifard, Ian P. Williamson and Mary-Ellen Feeney, Developing Spatial Data Infrastructures: From Concept to Reality, Taylor & Francis/CRC Press, 1st Edition, 2003, ISBN 978-0-415-30265-4. Routledge
2	Committee on Geo-information, ISO Standards and Geospatial Governance Reports,

	Elsevier, Latest Edition, Year and ISBN not specified.
3	Government of India, National Geospatial Policy 2022 and Related Government Policy Documents, Government of India Publications, Latest Edition, 2022, ISBN not applicable.
4	Paul A. Longley and others, Geospatial Analysis, Wiley, Latest Edition, Year and ISBN not specified.

Web links and Video Lectures (e–Resources)	
1	Department of Science & Technology, Government of India, Geospatial Policy resources.
2	Press Information Bureau release on National Geospatial Policy implementation.
3	Open Geospatial Consortium standards portal.
4	UN-GGIM standards guide on geospatial information management

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	Prepare metadata for a sample geospatial dataset	24
	OR	
2	Compare two geospatial standards used for interoperability	24
	OR	
3	Prepare a policy note on National Geospatial Policy 2022	24
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	Analyze a national geospatial portal and its standards compliance	24
	OR	
2	Design a poster on “Geospatial Data Standards for Governance”	24
	OR	
3	Complete a MOOC module on geospatial data management	24

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2		2	2	
CO2	3	3		2	3	
CO3	3	3	2	3	2	2
CO4	3	3	2	3	3	2
CO5	3	3	3	3	3	3

Semester: I						
Building Cost and Quality Management						
Course Code	**:**	1MCV105J		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50 Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50 Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Building Materials and Construction, Basic knowledge of Quantity Surveying.
Knowledge on Fundamental Concepts	Basic knowledge of building components, construction methods, measurements, quantities and costs.
Knowledge on Connected Tools (If any)	Spreadsheets and estimation software.

Course Learning Objectives: This course will enable the students to	
CLO1	Explain the principles and methods of estimating quantities for building works.
CLO2	Determine rates and costs of building works and assess construction quality using standard tests.
CLO3	Prepare measurements, bills and basic construction accounts for building works.
CLO4	Estimate and analyse the cost of building services such as water supply, sanitation and electrification.
CLO5	Evaluate building valuation and project completion requirements.

Module – 1	**08 Hrs**
Estimation of Building Quantities: Estimation of quantities for R.C.C. multistoried complex viz. earthwork, concrete in foundation, D.P.C., R.C.C. work, flooring and roofing, plastering and pointing etc., wood work, white washing	
Module – 2	**08 Hrs**
Rate Analysis and Construction Quality Control: Analysis of rates for multistoried building works – Brick work in foundations and Superstructure, cement concrete, R.C. C., Plastering, Flooring, Timber work etc. Checking of construction quality – various tests for bricks, cement, concrete, aggregates, and steel as per IS codes	
Module – 3	**08 Hrs**
Billing, Accounts and Arbitration: Preparation of bills for payment, measurement book, mode of payment, running account bill. Ledger and Cash book details, Arbitration.	
Module – 4	**08 Hrs**
Estimation and Cost Analysis of Building Services: Estimation of building services viz. water supply works, electrification, sanitary fitting etc, and their cost analysis.	
Module – 5	**08 Hrs**
Elements of Valuation and Project Completion: Valuation and Project Completion methods, techniques and examples Completion report of the project; Checking of Plan, Details of various works, and issue of completion report of the project.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the principles and methods of quantity estimation for multistoried buildings.
CO2	Apply rate analysis and standard quality assessment methods to building works.
CO3	Analyze measurement records, bills and construction accounts for building works.
CO4	Evaluate the costs of water supply, sanitary and electrical building services.
CO5	Develop valuation and completion documentation for building projects based on project records.

Text Books	
1	B. N. Dutta, Estimating and Costing in Civil Engineering: Theory and Practice Including Specifications and Valuations Calculations Based on DSR, CBS Publishers & Distributors, 29th Edition, 2026, ISBN: 978-93-49881-97-6.
2	S. C. Rangwala and K. B. Dalal, Estimating, Costing and Valuation, Charotar Publishing House Pvt. Ltd., 17th Edition, 2015, ISBN: 978-93-85039-05-8.
3	G. S. Birdie, Textbook of Estimating and Costing, Dhanpat Rai Publishing House, 2015, ISBN: 978-93-84559-51-9.

Reference Books	
1	M. Chakraborty, Estimating, Costing, Specifications and Valuation in Civil Engineering, 2006, ISBN 978-81-85304-36-6.
2	M. Chakraborty, Estimating, Costing, Specifications and Valuation in Civil Engineering, 2006, ISBN: 978-81-85304-36-6.
3	S. P. Bindra, Principles and Practice of Valuation, Dhanpat Rai Publications.
4	IS 1200 – Method of Measurement of Building and Civil Engineering Works, Bureau of Indian Standards.
5	IS 456 – Plain and Reinforced Concrete – Code of Practice, Bureau of Indian Standards.
6	IS 10262 – Concrete Mix Proportioning – Guidelines, Bureau of Indian Standards.

Web links and Video Lectures (e–Resources)	
1	Bureau of Indian Standards – https://www.bis.gov.in/
2	Central Public Works Department (CPWD) – https://cpwd.gov.in/
3	National Building Code of India Resources – https://www.bis.gov.in/
4	NPTEL – Civil Engineering Courses – https://nptel.ac.in/courses/civil-engineering
5	eGyanKosh – Civil Engineering Resources – https://egyankosh.ac.in/

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	**Assignment:** Prepare quantity estimates, rate analysis, bills and valuation for a multistoried building.	24
	OR	
2	**Case Study:** Prepare a simple cost and quality control report for a building project, including quantity estimation, rate analysis, billing and valuation.	24
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	**NPTEL/MOOC:** Selected lectures on quantity estimation, rate analysis, construction quality control, billing, valuation and	24

	project completion.	
	OR	
2	**Online Resources/Software Tutorials:** Study building estimation, billing, rate analysis and valuation using online resources and estimation software.	24

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	1	2	1
CO2	3	3	2	3	2	1
CO3	3	3	1	2	2	1
CO4	3	3	2	2	2	1
CO5	3	3	3	2	2	2

1MCV106X: Professional Elective Courses-II

Semester: I						
DIGITAL TWIN TECHNOLOGIES						
Course Code	**:**	1MCV106A		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	BIM, GIS and Internet of Things
Knowledge on Fundamental Concepts	Basic knowledge of BIM, IoT, sensors, databases and data analytics
Knowledge on Connected Tools (If any)	Basic knowledge of BIM/GIS software, IoT platforms and data visualization tools

Course Learning Objectives:	
CLO1	Describe digital twin concepts, architecture and enabling technologies.
CLO2	Apply data acquisition, IoT and data integration methods for digital twins.
CLO3	Analyze simulation, analytics and performance monitoring methods.
CLO4	Develop digital twin frameworks for civil infrastructure applications.
CLO5	Evaluate digital twin security, interoperability and lifecycle management for sustainable infrastructure.

Module – 1	**08Hrs**
Introduction to Digital Twin Concepts and Architecture: Definition and evolution of digital twins, difference between digital model, digital shadow, and digital twin, core components, physical asset representation, data-flow architecture, real-time synchronization, lifecycle perspective, and enabling technologies. Overview of BIM, CPS, IoT, cloud, edge computing, AI/ML, and visualization platforms. Civil engineering relevance in built assets, infrastructure monitoring, and smart cities. **Text Book 1:** Ch. 1 **Text Book 2:** Ch. 1 **Text Book 3:** Ch. 1	
Module – 2	**9Hrs**
Data Acquisition, IoT, and Connectivity for Digital Twins: Sensors, smart devices, data sources, telemetry, communication protocols, data quality, preprocessing, storage, and integration. IoT-based monitoring systems, wireless networks, gateways, cloud platforms, digital twin databases, and dashboard concepts. Data acquisition from structures, transportation assets, water infrastructure, and construction sites. Introduction to data fusion, calibration, and synchronization. **Text Book 1:** Ch. 2 **Text Book 2:** Ch. 2 **Text Book 3:** Ch. 2	
Module – 3	**9Hrs**
Modeling, Simulation, and Analytics in Digital Twins: Physics-based modeling, data-driven modeling, hybrid models, simulation lifecycle, model calibration, validation, updating, and uncertainty handling. Predictive analytics, condition monitoring, anomaly detection, performance forecasting, and scenario analysis. Applications of AI/ML, time-series analysis, and optimization in digital twin environments. Interpretation of model outputs for engineering decision-making.	

Text Book 1: Ch. 3
Text Book 2: Ch. 3
Text Book 3: Ch. 3

Module – 4	08 Hrs

Digital Twin Applications in Civil Engineering:

Digital twins for buildings, bridges, highways, metro systems, water supply networks, drainage systems, dams, and construction projects. Asset health monitoring, structural performance tracking, construction progress control, energy efficiency, maintenance planning, and resilience assessment. Integration with BIM, GIS, SCADA, and smart city platforms.

Text Book 1: Ch. 4
Text Book 2: Ch. 4
Text Book 3: Ch. 4

Module – 5	08 Hrs

Implementation, Interoperability, and Case Studies:

Digital twin deployment strategy, data governance, interoperability standards, cybersecurity, scalability, and lifecycle management. Cost-benefit aspects, implementation challenges, institutional requirements, and future trends. Case studies on infrastructure monitoring, smart buildings, transport systems, and water infrastructure. Digital twins for sustainability, resilience, and asset management.

Text Book 1: Ch. 5
Text Book 2: Ch. 5
Text Book 3: Ch. 5

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the concepts, architecture, and enabling technologies of digital twins in civil engineering and infrastructure systems.
CO2	Analyze data acquisition, sensor systems, data integration, and model updating methods used in digital twin environments.
CO3	Evaluate simulation, predictive analytics, and performance monitoring approaches for civil infrastructure applications.
CO4	Design digital twin frameworks for buildings, transportation, water systems, and construction projects.
CO5	Assess digital twin interoperability, security, lifecycle management, and develop solutions for resilient and sustainable infrastructure.

Text Books	
1	Michael Grieves and John Vickers, *Digital Twin: Mitigating Unpredictable, Undesirable Emergent Behavior in Complex Systems*, Springer, 1st Edition, 2017, ISBN 978-3-319-38755-0. The work is published as a chapter in *Transdisciplinary Perspectives on Complex Systems*.
2	Werner Kritzinger, Matthias Karner, Georg Traar, Jan Henjes and Wilfried Sihn, *Digital Twin in Manufacturing: A Categorical Literature Review and Classification*, Elsevier, 1st Edition, 2018, ISBN not applicable. This is a journal/conference paper rather than a conventional textbook.
3	Qinglin Qi and Fei Tao, *Digital Twin and Big Data Towards Smart Manufacturing and Industry 4.0: 360 Degree Comparison*, IEEE, 1st Edition, 2018, ISBN not applicable. This is an IEEE Access research article rather than a conventional textbook.
4	Antonino J. and others, *Smart Infrastructure and Digital Twin Applications in Civil Engineering*, Publisher, edition, year and ISBN not specified in the given syllabus.
Reference Books	
1	Aidan Fuller, Zhong Fan, Charles Day and Chris Barlow, *Digital Twin: Enabling Technologies, Challenges and Open Research*, IEEE, 1st Edition, 2020, ISBN not

	applicable.
2	Wang K. and others, *BIM, IoT and Digital Twin Integration for Infrastructure*, Publisher, edition, year and ISBN not specified in the given syllabus.
3	Booth C. and Pistor M., *Smart Cities and Infrastructure Digitalization*, Publisher, edition, year and ISBN not specified in the given syllabus.
4	Liu Y. and others, *Structural Health Monitoring and Digital Twin Concepts*, Publisher, edition, year and ISBN not specified in the given syllabus.

Web links and Video Lectures (e–Resources)	
1	NPTEL courses on BIM, IoT, AI/ML, and smart infrastructure.
2	IEEE and Springer articles on digital twin technologies.
3	Bentley, Autodesk, and Siemens digital twin learning resources.
4	Smart city and infrastructure digitalization resources from government and industry portals.

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	Mini Project: Digital twin frameworkfor a civil infrastructure asset. Deliverables: Report, architecture diagram, dashboard prototype	24
	OR	
2	Predictive maintenance model for a civil asset: Report, simulation output, recommendations	24
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	NPTEL/industry module reflections on digital twins	24
	OR	
2	Seminar on Digital twin case studies in transportation and water systems	24

CO – PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2			2	
CO2	3	3		2	3	
CO3	3	3	2	3	3	
CO4	3	3	3	3	3	2
CO5	3	3	3	3	3	3

Semester: I						
OPTIMIZATION TECHNIQUES FOR CIVIL SYSTEMS						
Course Code	**:**	1MCV106B		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Engineering Mathematics, Numerical Methods, Basic Civil Engineering
Knowledge on Fundamental Concepts	Basic knowledge of mathematics, equations, matrices, and engineering problem formulation
Knowledge on Connected Tools (If any)	Basic knowledge of Excel, MATLAB or Python

Course Learning Objectives:	
CLO1	Describe optimization concepts, problem formulation, objectives, constraints, and decision variables.
CLO2	Apply linear programming and resource optimization techniques to civil engineering problems.
CLO3	Analyze transportation, assignment, and network optimization models for civil systems.
CLO4	Develop optimal solutions using nonlinear, integer, dynamic, and multi-objective optimization methods.
CLO5	Evaluate computational optimization methods and their applications in civil engineering systems.

Module – 1	**08Hrs**
Optimization Fundamentals and Problem Formulation: Introduction to optimization, role of optimization in civil engineering, decision variables, objective functions, constraints, feasible region, optimal solution, single-variable and multivariable optimization, classification of optimization problems, model formulation, engineering design interpretation, basics of convexity, and sensitivity concepts. Civil applications in structural, transportation, water resources, and construction systems. **Text Book 1:** Ch. 1 **Text Book 2:** Ch. 1 **Text Book 3:** Ch. 1	
Module – 2	**9Hrs**
Linear Programming and Engineering Applications: Linear programming formulation, standard form, graphical method, simplex method concepts, duality, shadow price, reduced cost, sensitivity analysis, and optimization of resources. Applications to mix design, material allocation, land use planning, irrigation scheduling, project budgeting, and resource distribution in civil systems. Introduction to spreadsheet-based LP solving and basic computational tools. **Text Book 1:** Ch. 2 **Text Book 2:** Ch. 3 **Text Book 3:** Ch. 3	
Module – 3	**9Hrs**

Transportation, Assignment and Network Models:

Transportation problem, balanced and unbalanced models, initial basic feasible solutions, optimality tests, assignment problem, Hungarian method concepts, shortest path, minimum spanning tree, maximum flow, transshipment, and network representation. Applications in logistics, construction material movement, utility networks, traffic routing, and infrastructure service optimization.

Text Book 1: Ch. 5

Text Book 2: Ch. 4

Text Book 3: Ch. 9

Module – 4	08 Hrs

Nonlinear, Integer and Dynamic Optimization:

Nonlinear programming concepts, unconstrained and constrained optimization, Lagrange multipliers, KKT basics, integer programming, binary variables, branch-and-bound concepts, dynamic programming, goal programming, and multi-objective optimization. Civil engineering applications in design optimization, project sequencing, equipment selection, cost-time trade-offs, and facility location.

Text Book 1: Ch. 9

Text Book 2: Ch. 7

Text Book 3: Ch. 11

Module – 5	08 Hrs

Computational Methods and Civil Case Studies:

Optimization algorithms overview, heuristic and metaheuristic methods, genetic algorithms, simulated annealing, particle swarm optimization, gradient-based methods, software tools for optimization, interpretation of results, and model validation. Integrated case studies on structural design optimization, water distribution systems, traffic signal timing, construction planning, and sustainable infrastructure decision-making.

Text Book 1: Ch. 10

Text Book 2: Ch. 12

Text Book 3: Ch. 13

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the fundamentals of optimization, mathematical formulation, objective functions, constraints, and design variables relevant to civil engineering problems.
CO2	Apply linear programming, graphical methods, and simplex-based concepts to solve civil engineering optimization problems.
CO3	Analyze transportation, water resources, structural, and construction-related systems using suitable deterministic optimization techniques.
CO4	Design optimal solutions for civil systems considering cost, time, safety, sustainability, and performance constraints.
CO5	Evaluate optimization approaches for infrastructure planning and develop integrated optimization-based civil engineering solutions using analytical and computational methods.

Text Books	
1	Hamdy A. Taha, Operations Research: An Introduction, Pearson, 10th Edition, 2017, ISBN 978-1-292-16554-7.

2	Singiresu S. Rao, Engineering Optimization: Theory and Practice, Wiley, 5th Edition, 2019, ISBN 978-1-119-45471-7.
3	Frederick S. Hillier and Gerald J. Lieberman, Introduction to Operations Research, McGraw-Hill, 12th Edition, 2025, ISBN 978-93-6444-450-7.
4	Kalyanmoy Deb, Optimization for Engineering Design: Algorithms and Examples, PHI Learning, 2nd Edition, 2012, ISBN 978-81-203-4678-9.
Reference Books	
1	Jasbir Singh Arora, Introduction to Optimum Design, Academic Press, 4th Edition, 2016, ISBN 978-0-128-00918-5.
2	Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows, Wiley, 4th Edition, 2010, ISBN 978-0-470-46272-0.
3	Edwin K. P. Chong and Stanislaw H. Żak, An Introduction to Optimization, Wiley, 4th Edition, 2013, ISBN 978-1-118-27901-4.
4	Wayne L. Winston and Jeffrey B. Goldberg, Operations Research: Applications and Algorithms, Thomson/Brooks/Cole, 4th Edition, 2004, ISBN 978-0-534-42058-8.

Web links and Video Lectures (e–Resources)	
1	NPTEL courses on optimization methods, operations research, and engineering design.
2	MIT Open Courseware resources on optimization and linear programming.
3	COURSERA and SWAYAM resources on optimization and decision science.
4	MATLAB, Python, Excel Solver, and other open-source optimization tool documentation.
5	Case studies and notes from professional bodies and civil engineering research portals.

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	**Formulation of a civil engineering optimization problem:** Problem statement, variables, objective function, constraints, assumptions	24
	OR	
2	**Linear programming case study:** LP model, solution steps interpretation	24
	OR	
3	**Mini-project using MATLAB / Python / spreadsheet:** Working model, results, and presentation	24
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	Review of one research paper on optimization in civil engineering	24
	OR	
2	Study of one software / solver tool	24
	OR	
3	Case study on a real civil system	24

CO – PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2			2	
CO2	3	3		2	3	
CO3	3	3		3	3	
CO4	3	3	3	3	3	2
CO5	3	3	3	3	3	3

Semester: I						
SMART CITIES AND URBAN ANALYTICS						
Course Code	**:**	1MCV106C		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	GIS and Remote Sensing, Urban Planning, Data Analytics
Knowledge on Fundamental Concepts	Basic knowledge of GIS, urban systems, statistics, data handling and sustainability
Knowledge on Connected Tools (If any)	Basic knowledge of GIS software, Excel, dashboards and data visualization tools

Course Learning Objectives:	
CLO1	Describe smart city concepts, urban systems, challenges and governance frameworks.
CLO2	Analyze urban data sources, indicators, quality and trends for city-level decision-making
CLO3	Apply GIS, remote sensing, IoT and statistical methods for urban analytics.
CLO4	Evaluate urban infrastructure systems using spatial, temporal and multi-criteria approaches.
CLO5	Develop data-driven solutions for smart cities considering ethics, privacy, sustainability and resilience.

Module – 1	**08Hrs**
Smart Cities Fundamentals: • Introduction to smart cities, sustainable urbanization, smart city dimensions, global and Indian initiatives, city systems, stakeholders, and governance models. • Urban challenges: mobility, housing, water, energy, sanitation, environment, public safety, digital divide, and inclusion. • Concepts of urban intelligence, smart services, data-driven governance, and human-centred planning. **Text Book 1:** Ch. 1 **Text Book 2:** Ch. 1 **Text Book 3:** Ch. 1	
Module – 2	**9Hrs**
Urban Data Ecosystem: • Sources of urban data: census, surveys, administrative records, open data, IoT sensors, satellite data, social media, and citizen-generated data. • Data formats, data cleaning, quality control, metadata, interoperability, and urban indicators. • Statistical summaries, trend analysis, anomaly detection, and data ethics in city analytics. **Text Book 1:** Ch. 4 **Text Book 2:** Ch. 3 **Text Book 3:** Ch. 4	
Module – 3	**9Hrs**

GIS and Spatial Analytics:

- Basics of GIS, geocoding, layering, thematic mapping, spatial queries, spatial interpolation, and network analysis.
- Remote sensing for land use/land cover, urban growth, heat island mapping, and infrastructure monitoring.
- Introduction to dashboarding, spatial visualization, and geospatial decision support for city applications.

Text Book 1: Ch. 5
Text Book 2: Ch. 4
Text Book 3: Ch. 5

Module – 4	08 Hrs

Urban Modeling and Simulation:

- Urban systems modeling, demand forecasting, scenario analysis, agent-based concepts, and digital twins.
- Applications in transport, land use, utilities, environmental quality, and disaster preparedness.
- Multi-criteria decision making, performance metrics, and prioritization of smart city interventions.

Text Book 1: Ch. 7
Text Book 2: Ch. 5
Text Book 3: Ch. 7

Module – 5	08 Hrs

Applications and Governance:

- Smart mobility, smart energy, smart water, smart waste, e-governance, public health, and urban resilience applications.
- Cybersecurity, privacy, data governance, policy, financing, and institutional frameworks for smart cities.
- Case studies and project-based analysis of an urban problem using data-driven approaches.

Text Book 1: Ch. 10
Text Book 2: Ch. 8
Text Book 3: Ch. 10

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the concepts, evolution, components, and governance frameworks of smart cities.
CO2	Analyze urban data sources, indicators, and data quality issues for city-level decision-making.
CO3	Apply GIS, remote sensing, IoT, and statistical methods for urban analytics and visualization.
CO4	Evaluate urban infrastructure systems using spatial, temporal, and multi-criteria approaches.
CO5	Develop data-driven solutions for smart cities and assess ethics, privacy, sustainability, and resilience in smart city planning and operations.

Text Books	
1	Anthony M. Townsend, Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia, W. W. Norton & Company, 1st Edition, 2013, ISBN 978-0-393-08287-6.
2	Carlo Ratti and Matthew Claudel, The City of Tomorrow: Sensors, Networks, Hackers, and the Future of Urban Life, Yale University Press, 1st Edition, 2016, ISBN 978-0-300-20480-3.
3	Michael Batty, The New Science of Cities, MIT Press, 1st Edition, 2013, ISBN 978-0-

	262-01952-1.
4	Robert K. Yin, Case Study Research and Applications: Design and Methods, SAGE Publications, 6th Edition, 2017, ISBN 978-1-5063-3616-9.
Reference Books	
1	Wenzhong Shi, Michael F. Goodchild, Michael Batty, Mei-Po Kwan and Anshu Zhang, Urban Informatics, Springer Singapore, 1st Edition, 2021, ISBN 978-981-15-8982-9.
2	Mohammad Ayoub Khan, Fahad Algarni and Mohammad Tabrez Quasim, Smart Cities: A Data Analytics Perspective, Springer, 1st Edition, 2021, ISBN 978-3-030-60922-1.
3	T. M. Vinod Kumar, E-Governance for Smart Cities, Springer Singapore, 1st Edition, 2015, ISBN 978-981-287-286-9.
4	John R. Vacca, Solving Urban Infrastructure Problems Using Smart City Technologies, Elsevier, 1st Edition, 2020, ISBN 978-0-12-816816-5.
5	Poonam Sharma and Swati Rajput, Sustainable Smart Cities in India: Challenges and Future Perspectives, Springer Cham, 1st Edition, 2017, ISBN 978-3-319-47144-0.

Web links and Video Lectures (e–Resources)	
1	VTU syllabus and academic guidelines portal.
2	NPTEL/SWAYAM resources on GIS, urban planning, and data analytics.
3	Smart city mission and urban data resources from government/open-data portals.
4	Online GIS platforms, dashboards, and urban analytics tutorials.
5	Academic case studies and reports on smart cities and urban analytics.

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	**Urban Data Profiling Exercise**: Activity: Collect and clean a small city dataset, compute indicators, identify missing values, and present trends using tables or charts. Linked COs: CO2, CO3.	24
	OR	
2	**GIS Thematic Mapping Assignment:** Activity: Prepare a thematic map for land use, transport access, heat island, or service availability using GIS or open geospatial tools. Linked COs: CO3, CO4.	24
	OR	
3	**Mini-Project on Urban Service Analytics:** Activity: Develop a brief solution for one urban service such as water, waste, energy, or flood monitoring with data-driven recommendations. Linked COs: CO5, CO6.	24
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	Read a smart-city policy and prepare a reflective note	24
	OR	
2	Review one city dashboard or urban data portal and summarize its usefulness.	24
	OR	
3	Watch a MOOC/video module on GIS, IoT, or urban analytics and submit a learning note.	24

CO – PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2			2	2
CO2	3	3		3	3	2
CO3	3	3	2	3	3	2
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

Semester: I						
ROBOTICS & AUTOMATION IN CONSTRUCTION						
Course Code	**:**	1MCV106D		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Construction Technology, BIM and Automation
Knowledge on Fundamental Concepts	Basic knowledge of construction methods, sensors, control systems and digital technologies
Knowledge on Connected Tools (If any)	Basic knowledge of MATLAB, Python, BIM software and simulation tools

Course Learning Objectives:	
CLO1	Describe robotics, automation, sensing and control concepts used in construction.
CLO2	Apply robotic sensing, actuators and control methods to construction tasks.
CLO3	Analyze automated construction processes, equipment and material handling systems.
CLO4	Develop automation strategies for construction planning, monitoring, execution and safety.
CLO5	Evaluate AI-enabled robotics and automation solutions for smart construction and infrastructure.

Module – 1	**08Hrs**

Robotics and Automation Fundamentals:

Introduction to robotics, automation in construction, historical development, need for robotics in the construction industry, classification of robots, robot anatomy, degrees of freedom, coordinate systems, end effectors, sensors, actuators, and basic control concepts. Overview of construction automation, safety, productivity, quality, and human-robot interaction in construction environments.

Text Book 1: Ch. 1

Text Book 2: Ch. 1

Text Book 3: Ch. 1

Module – 2	**9Hrs**

Sensing, Control and Navigation:

Construction sensing technologies, vision systems, LiDAR, GNSS, IMU, proximity sensors, force and torque sensors, signal processing basics, feedback control, path planning, localization, mapping, obstacle detection, and navigation concepts. Applications in surveying, site inspection, layout marking, earthwork monitoring, and autonomous site vehicles.

Text Book 1: Ch. 4

Text Book 2: Ch. 3

Text Book 3: Ch. 3

Module – 3	**9Hrs**

Construction Robotics and Automated Equipment:

Robotic excavators, automated cranes, bricklaying robots, 3D concrete printing systems, demolition robots, rebar tying robots, finishing robots, material handling robots, and exoskeletons. Automated machinery for earthmoving, tunneling, road construction, and precast operations. Performance parameters, advantages, limitations, and field deployment challenges.

Text Book 1: Ch. 6

Text Book 2: Ch. 4

Text Book 3: Ch. 5

Module – 4	08 Hrs

Digital Integration and Smart Construction:

Building Information Modelling (BIM), digital twins, IoT-enabled monitoring, cloud platforms, computer vision, AI-based inspection, machine learning for progress tracking, safety analytics, and data-driven decision-making.

Integration of robotics with BIM, site logistics automation, schedule monitoring, and quality control in construction projects.

Text Book 1: Ch. 7
Text Book 2: Ch. 5
Text Book 3: Ch. 8

Module – 5	08 Hrs

Autonomous Systems and Case Studies:

Autonomous and semi-autonomous construction systems, swarm robotics concepts, drone applications, robotic inspection, asset monitoring, predictive maintenance, safety management, and sustainability considerations.

Case studies on automated building construction, infrastructure inspection, highway works, and smart site management. Future trends in construction robotics, Industry 4.0, and AI-assisted project execution.

Text Book 1: Ch. 8

Text Book 2: Ch. 6

Text Book 3: Ch. 10

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the fundamentals of robotics, automation, sensing, and control relevant to construction applications.
CO2	Apply robotic system concepts, actuators, and control methods to construction-related tasks and operations.
CO3	Analyze automated construction processes, site operations, and material handling systems using suitable technologies.
CO4	Design automation strategies for construction planning, monitoring, execution, and safety improvement.
CO5	Evaluate AI-enabled construction systems and develop integrated robotics and automation solutions for smart construction and infrastructure delivery.

Text Books	
1	Thomas Bock and Thomas Linner, Robot-Oriented Design: Design and Management Tools for the Deployment of Automation and Robotics in Construction, Cambridge University Press, 1st Edition, 2015, ISBN 978-1-107-07638-9.
2	Thomas Bock and Thomas Linner, Site Automation: Automated/Robotic On-Site Factories, Cambridge University Press, 1st Edition, 2016, ISBN 978-1-107-07597-9.
3	Anil Sawhney, Michael Riley and Javier Irizarry (Editors), Construction 4.0: An Innovation Platform for the Built Environment, Routledge, 1st Edition, 2020, ISBN 978-0-367-02730-8.
4	Roland Siegwart, Illah Reza Nourbakhsh and Davide Scaramuzza, Introduction to Autonomous Mobile Robots, MIT Press, 2nd Edition, 2011, ISBN 978-0-262-01535-6.
5	John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson, 4th Edition, 2022, ISBN 978-0-13-784874-4.
6	Bruno Siciliano and Oussama Khatib (Editors), Springer Handbook of Robotics, Springer, 2nd Edition, 2016, ISBN 978-3-319-32550-7.
Reference Books	

1	John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson, 4th Edition, 2022, ISBN 978-0-13-784874-4.
2	Thomas Bock and Thomas Linner, Construction Robotics: Elementary Technologies and Single Task Construction Robots, Cambridge University Press, 1st Edition, 2016, ISBN 978-1-107-07599-3.

Web links and Video Lectures (e–Resources)	
1	NPTEL courses on robotics, automation, mechatronics, and construction management.
2	IEEE and ASCE digital libraries for construction robotics research.
3	BIM and digital twin tutorials from Autodesk and other professional platforms.
4	MATLAB, Python, ROS, and computer vision documentation.
5	MOOC content from SWAYAM, Coursera, and open educational resources on robotics and smart construction.

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	Case study on robotic execution of a construction task: task planning, workflow, benefits, and limitations.	24
	OR	
2	Mini-project using MATLAB / Python / simulation software / BIM tool on robotic site automation.	24
	OR	
3	Formulations of a robotics-based construction problem: problem statement, system components, sensing, control, and constraints.	24
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	Review of one research paper on construction robotics.	24
	OR	
2	Study of one software or simulation tool related to robotics or automation.	24

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**2**			**2**	
CO2	**3**	**3**	**2**	**2**	**3**	
CO3	**3**	**3**	**2**	**3**	**3**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**

Semester: I						
IOT AND SMART SENSORS FOR CIVIL ENGINEERING						
Course Code	**:**	1MCV106E		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Basic Electronics, Programming, Civil Engineering Fundamentals
Knowledge on Fundamental Concepts	Sensors, data communication, programming and civil systems
Knowledge on Connected Tools (If any)	Arduino, ESP32, Raspberry Pi, Excel and Python

Course Learning Objectives:	
CLO1	Describe IoT concepts, smart sensors and their applications in civil engineering.
CLO2	Apply sensor technologies for monitoring civil structures and infrastructure.
CLO3	Analyze IoT hardware, communication protocols and sensor data for civil applications.
CLO4	Develop IoT-based monitoring solutions for civil infrastructure systems
CLO5	Evaluate IoT data analytics, visualization, cybersecurity and smart infrastructure applications.

Module – 1	**08Hrs**
Introduction to IoT and Smart Sensing: Overview of IoT, evolution of smart infrastructure, components of IoT systems, sensing and actuation, data flow in IoT, edge and cloud concepts, and relevance of IoT in civil engineering. Applications in smart buildings, bridges, roads, water distribution, smart cities, and environmental monitoring. **Text Book 1:** Ch. 1	
Module – 2	**10Hrs**
Sensor Technology for Civil Engineering; Principles of measurement, sensor characteristics, calibration, accuracy, precision, sensitivity, range, and response time. Types of sensors: strain gauges, accelerometers, displacement sensors, pressure sensors, temperature sensors, humidity sensors, tilt sensors, vibration sensors, flow sensors, level sensors, and corrosion sensors. Sensor selection criteria for structural and infrastructure applications. **Text Book 1:** Ch. 2	
Module – 3	**10Hrs**
IoT Hardware and Communication: Microcontrollers and embedded platforms such as Arduino, ESP32, and Raspberry Pi. Signal conditioning, analog-to-digital conversion, data logging, and power management. Communication technologies: Wi-Fi, Bluetooth, Zigbee, LoRa, NB-IoT, and GSM; introduction to MQTT and HTTP protocols. **Text Book 1:** Ch. 3	
Module – 4	**08 Hrs**

Civil Engineering Monitoring Applications
IoT-based structural health monitoring of buildings, bridges, and towers. Monitoring of pavements, slopes, retaining walls, dams, tunnels, and pipelines. Smart water supply monitoring, leakage detection, flood monitoring, air quality monitoring, and noise monitoring. **Text Book 1:** Ch. 4
Module – 5 **06 Hrs**
Data Analytics, Visualization, and Smart Infrastructure: Sensor data storage, preprocessing, visualization, threshold-based alerts, and introduction to analytics for condition monitoring. Basic concepts of dashboards, cloud platforms, predictive maintenance, and digital twins for civil infrastructure. Cybersecurity, data reliability, scalability, sustainability, and ethical issues in IoT-enabled infrastructure systems. **Text Book 1:** Ch. 5

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the fundamentals of robotics, automation, sensing, and control relevant to construction applications.
CO2	Apply robotic system concepts, actuators, and control methods to construction-related tasks and operations.
CO3	Analyze automated construction processes, site operations, and material handling systems using suitable technologies.
CO4	Design automation strategies for construction planning, monitoring, execution, and safety improvement.
CO5	Evaluate AI tools and digital workflows and develop robotics and automation solutions for smart construction.

Text Books	
1	Michael Grieves and John Vickers, Digital Twin: Mitigating Unpredictable, Undesirable Emergent Behavior in Complex Systems, Springer, 1st Edition, 2017, ISBN 978-3-319-38754-3 , 978-3-319-38756-7.
2	Werner Kritzinger, Matthias Karner, Georg Traar, Jan Henjes and Wilfried Sihn**,** Digital Twin in Manufacturing: A Categorical Literature Review and Classification**,** Elsevier/IFAC-PapersOnLine, 1st Edition, 2018.
3	Qinglin Qi and Fei Tao, Digital Twin and Big Data Towards Smart Manufacturing and Industry 4.0: 360 Degree Comparison**,** IEEE Access, 1st Edition, 2018,. Note: This is a research article published in IEEE Access, Volume 6, pp. 3585–3593**.**
4	Antonino J. et al., Smart Infrastructure and Digital Twin Applications in Civil Engineering**,**
Reference Books	
1	Aidan Fuller, Zhong Fan, Charles Day and Chris Barlow, Digital Twin: Enabling Technologies, Challenges and Open Research, *IEEE, 1st Edition, 2020.* Published as a research article in IEEE Access, Vol. 8, pp. 108952–108971**.**
2	K. Wang et al., BIM, IoT and Digital Twin Integration for Infrastructure**.**
3	C. Booth and M. Pistor, Smart Cities and Infrastructure Digitalization**.**
4	Y. Liu et al., Structural Health Monitoring and Digital Twin Concepts with Sustainability Add-ons**,**

Web links and Video Lectures (e–Resources)	
1	NPTEL courses on BIM, IoT, AI/ML, and smart infrastructure.
2	IEEE and Springer articles on digital twin technologies.
3	Bentley, Autodesk, and Siemens digital twin learning resources.

4	Smart city and infrastructure digitalization resources from government and industry portals.
5	Research datasets and dashboards for structural health monitoring, traffic, and water systems

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	Mini-project on IoT-based monitoring of a civil structure	24
	OR	
2	Case study on smart water leakage detection using sensors and remote alerts.	24
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	NPTEL/online modules related to IoT and smart infrastructure	24
	OR	
2	Survey and presentation on sensor technologies used in structural health monitoring	24

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2			2	2
CO2	3	3	2	3	3	2
CO3	3	3	2	3	3	2
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

Semester: I						
SMART SOLID WASTE MANAGEMENT AND CIRCULAR ECONOMY SYSTEMS						
Course Code	**:**	1MCV106F		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Environmental Engineering, Environmental Science
Knowledge on Fundamental Concepts	Basic knowledge of solid waste, waste collection, treatment and disposal
Knowledge on Connected Tools (If any)	Basic knowledge of Excel, GIS, IoT sensors and data visualization tools

Course Learning Objectives:	
CLO1	Describe solid waste types, characteristics, collection, processing and disposal methods.
CLO2	Analyze waste data, generation patterns and operational performance using digital tools.
CLO3	Evaluate waste collection, transport, treatment and resource recovery systems.
CLO4	Develop smart waste management and monitoring solutions for urban and institutional areas.
CLO5	Develop circular economy and sustainable waste management solutions for municipal planning.

Module – 1	**09Hrs**

Solid Waste Fundamentals and Urban Waste Streams:

Introduction to solid waste management, municipal solid waste, commercial waste, institutional waste, construction and demolition waste, biomedical waste, plastic waste, e-waste, and industrial wastes. Waste generation sources, composition, quantity estimation, density, moisture content, and calorific value. Waste hierarchy, 3R principles, segregation at source, collection systems, storage, transfer stations, and disposal options. Public health, environmental, and engineering relevance of solid waste management.

Text Book 1: Ch. 1

Text Book 2: Ch. 1

Text Book 3: Ch. 1

Module – 2	**9Hrs**

Waste Characterization, Data Analysis and Smart Monitoring:

Waste sampling and characterization methods, physical and chemical properties, waste audit procedures, generation trend analysis, seasonal variation, per-capita waste estimation, and diversion indicators. Data collection from households, institutions, and municipalities. Use of spreadsheets, dashboards, GIS, IoT sensors, QR/RFID-based tracking, and simple analytics for route and facility monitoring.

Text Book 1: Ch. 2

Text Book 2: Ch. 2

Text Book 3: Ch. 2

Module – 3	**9Hrs**

Collection Systems, Segregation, Transport and Processing:

Primary and secondary collection systems, source segregation methods, material recovery facilities, manual and mechanized handling, transfer and transport optimization, route planning, and fleet management.

Processing technologies including composting, vermicomposting, biomethanation, refuse-derived fuel, recycling, incineration, pyrolysis, and sanitary landfill design. Occupational safety, leachate control, odour management, and lifecycle environmental impacts.

Text Book 1: Ch. 5

Text Book 2: Ch. 3

Text Book 3: Ch. 3

Module – 4	**08Hrs**

Circular Economy, Resource Recovery and Waste-to-Value Planning:

Circular economy concepts, sustainable production and consumption, product life extension, design for reuse and recycling, industrial symbiosis, extended producer responsibility, and zero-waste planning. Resource recovery from organic waste, plastics, paper, metals, construction waste, and e-waste. Life cycle thinking, carbon footprint basics, material flow analysis, cost-benefit considerations, and planning of waste-to-value systems for urban and institutional settings.

Text Book 1: Ch. 8

Text Book 2: Ch. 4

Text Book 3: Ch. 4

Module – 5	**07Hrs**

Integrated Smart Waste Management and Circular Economy Case Studies:

Smart city waste management concepts, digital platforms, community participation, behavioural change, decentralised systems, performance monitoring, and policy implementation. National and international frameworks related to solid waste management and circular economy. Case studies on decentralized composting, ward-level segregation, smart collection models, construction waste recycling, and circular campus or smart city waste management plans.

Text Book 1: Ch. 14

Text Book 2: Ch. 5

Text Book 3: Ch. 5

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain solid waste generation, classification, collection, segregation, treatment and disposal.
CO2	Analyze waste generation, composition and management data using suitable tools.
CO3	Evaluate waste management systems, segregation, transportation and environmental impacts.
CO4	Design smart waste collection, treatment, recovery and monitoring systems.
CO5	Assess circular economy practices for sustainable waste management and municipal planning.

Text Books	
1	George Tchobanoglous, Hilary Theisen and S. A. Vigil, Integrated Solid Waste Management: Engineering Principles and Management Issues**,** McGraw-Hill, 2nd Edition, 1993, ISBN 978-0-07-063237-0. The 2nd edition and ISBN are catalogued by Google Books.
2	S. Kumar and A. Bhattacharyya, *Smart Waste Management Systems***.**
3	S. K. Ghosh, *Municipal Solid Waste Management in India*, CRC Press.

4	P. Agamuthu, *Solid Waste Management in Asia*, Springer, 1st Edition, 2013/2014, ISBN 978-981-4451-72-7.
5	R. C. Gupta, *Solid and Hazardous Waste Management*, Khanna Publishers.
6	Trevor M. Letcher and Daniel A. Vallero, *Waste: A Handbook for Management*, Academic Press, 2nd Edition, 2019, ISBN 978-0-12-815060-3.
7	Walter R. Stahel, *The Circular Economy: A User's Guide*, Routledge, 1st Edition, 2019, ISBN 978-0-367-20017-6.
8	Christina Meskers, Ernst Worrell and Markus A. Reuter, *Handbook of Recycling: State-of-the-Art for Practitioners, Analysts, and Scientists*, Elsevier, 2nd Edition, 2024, ISBN 978-0-323-85514-3.
Reference Books	
1	David C. Wilson, L. Rodic and others, *Waste Management and Circular Economy*, Routledge
2	P. R. White, M. Franke and P. Hindle, *Integrated Solid Waste Management: A Lifecycle Inventory*, Springer, 1st Edition, 1995, ISBN 978-0-8342-1311-1.
3	United Nations Environment Programme (UNEP) and International Solid Waste Association (ISWA), *Global Waste Management Outlook 2024: Beyond an Age of Waste – Turning Rubbish into a Resource*, United Nations Environment Programme, 1st Edition, 2024, ISBN 978-92-807-4129-2.
4	Ellen MacArthur Foundation, *Circular Economy Reports and Toolkits*, Ellen MacArthur Foundation.
5	M. R. Verma, *Municipal Solid Waste Management*.
6	N. J. Themelis and others, *Waste-to-Energy: Technologies and Applications*,

Web links and Video Lectures (e–Resources)	
1	CPCB and MoHUA resources on municipal solid waste management.
2	CPHEEO manuals and urban local body waste management guidelines.
3	NPTEL courses on waste management, sustainability, and circular economy.
4	UNEP, UN-Habitat, and Ellen MacArthur Foundation learning resources.
5	Smart city mission resources, municipal dashboards, and waste analytics portals.

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	Waste audit and composition analysis for a local site/campus	24
	OR	
2	Design of solid waste management system for a campus/local area	24
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	MOOC course on Solid waste management	24
	OR	
2	Waste-to-energy recovery techniques	24

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2			2	2
CO2	3	3		2	3	2
CO3	3	3		3	2	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

Semester: I						
CLOUD PLATFORMS & BIG DATA FOR GEOSPATIAL APPLICATIONS						
Course Code	**:**	1MCV106G		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	GIS, Remote Sensing, Database Management
Knowledge on Fundamental Concepts	GIS, spatial data, databases, programming and data analytics
Knowledge on Connected Tools (If any)	Python, SQL, GIS software, cloud platforms and data visualization

Course Learning Objectives:	
CLO1	Describe cloud computing, geospatial data and big data concepts.
CLO2	Analyze distributed computing and big data frameworks for geospatial applications.
CLO3	Apply cloud-based spatial databases, indexing and query techniques.
CLO4	Develop scalable geospatial analytics workflows using cloud and distributed tools.
CLO5	Evaluate GeoAI and cloud-based solutions for smart cities, environmental monitoring and sustainable infrastructure.

Module – 1	**08Hrs**

Foundations of Cloud Computing for Geospatial Data:

Introduction to cloud computing concepts, service models (IaaS, PaaS, SaaS), deployment models, virtualization, containers, and serverless computing. Geospatial data types and characteristics: raster, vector, point clouds, spatiotemporal and streaming data. Data life cycle, metadata, data governance, and cloud storage basics. Overview of cloud security, access control, cost models, and scalability requirements for geospatial workloads.

Text Book 1: Ch. 1

Text Book 2: Ch. 1

Text Book 3: Ch. 1

Module – 2	**10Hrs**

Distributed Computing and Big Data Frameworks:

Big data characteristics, distributed computing principles, parallelism, partitioning, and fault tolerance. Hadoop ecosystem: HDFS, MapReduce, YARN, Hive, HBase, and Spark for geospatial analytics. Data ingestion from remote sensing, GNSS, UAV, and IoT sources. Batch versus stream processing, ETL pipelines, and performance considerations for large spatial datasets. Introduction to cloud-native geospatial processing architecture.

Text Book 1: Ch. 2

Text Book 2: Ch. 4

Text Book 3: Ch. 3

Module – 3	**10Hrs**

Cloud Geospatial Data Management:

Cloud-enabled spatial databases, object storage, data lakes, and Lakehouse concepts. Spatial indexing, tiling, pyramids, partitioning, and compression techniques for large geodata. Cloud

geodatabases, geospatial metadata catalogs, and web services for data access. Query processing for raster and vector data, spatial joins, proximity search, and distributed query optimization. Introduction to PostGIS on cloud platforms and geospatial APIs.

Text Book 1: Ch. 3

Text Book 2: Ch. 5

Text Book 3: Ch. 7

Module – 4	08 Hrs

Scalable Geospatial Analytics:

Cloud-based geospatial analysis workflows for land use mapping, urban growth analysis, flood monitoring, and
transportation planning. Use of Python, Jupyter, GeoPandas, Rasterio, xarray, and Spark-based geospatial processing. Cloud execution of image classification, time-series analysis, change detection, and hotspot detection..

Workflow automation using notebooks, functions, and workflow orchestration tools.

Integration of open geospatial standards and interoperable services.

Text Book 1: Ch. 4

Text Book 2: Ch. 6

Text Book 3: Ch. 8

Module – 5	06 Hrs

GeoAI, IoT, and Decision Support:

Big data pipelines for satellite, LiDAR, UAV, and IoT streams. Cloud-supported GeoAI using machine learning and deep learning for classification, segmentation, anomaly detection, and prediction. Decision support systems for smart cities, disaster management, infrastructure monitoring, and environmental sustainability. Case studies using cloud geospatial platforms, open data portals, and web dashboards. Ethical issues, reproducibility, data privacy, and sustainable computing.

Text Book 1: Ch. 5

Text Book 2: Ch. 7

Text Book 3: Ch. 9

Course Outcomes: After completing the course, the students will be able to	
CO1	Analyze geospatial data characteristics and data lifecycle requirements for cloud-based processing and storage.
CO2	Evaluate cloud platforms, distributed computing models, and big data frameworks for geospatial applications.
CO3	Analyze spatial data management, indexing, and query methods in cloud-enabled geodatabases.
CO4	Create scalable workflows for geospatial analytics using cloud tools, APIs, and distributed processing engines.
CO5	Design big data pipelines and evaluate cloud-based geospatial solutions for smart cities, environmental monitoring, and sustainable infrastructure.

Text Books	
1	P. K. Biswas and S. K. Bhatia, *Cloud Computing and Big Data Technologies*.
2	Ian Foster, Dennis B. Gannon and Jack Dongarra, *Cloud Computing for Science and Engineering*, MIT Press, 1st Edition, 2017, ISBN 978-0-262-53378-2.
3	Shashi Shekhar and Hui Xiong, *Encyclopedia of GIS*, Springer, 1st Edition, 2008, ISBN 978-0-387-35973-1.
4	Michael Stonebraker, *Big Data and Data Science for Geospatial Applications*.
5	Rajkumar Buyya, James Broberg and Andrzej M. Goscinski, *Cloud Computing:*

	Principles and Paradigms, Wiley, 1st Edition, 2011, ISBN 978-0-470-88799-8.
6	Haluk Demirkan and Dursun Delen, *Managing Big Data Analytics: From Strategic Planning to Enterprise Integration*, Springer, 1st Edition, 2013, ISBN 978-3-642-37740-6.
7	Kang-tsung Chang, *Introduction to Geographic Information Systems*, McGraw-Hill, 9th Edition, 2019, ISBN 978-1-259-92164-4.
8	Paul A. Longley, Michael F. Goodchild, David J. Maguire and David W. Rhind, *Geographic Information Systems and Science*, Wiley, 4th Edition, 2015, ISBN 978-1-118-67695-0.
Reference Books	
1	Jonathan J. Craig, *Introduction to Robotics: Mechanics and Control*, Pearson, 4th Edition, 2018, ISBN 978-0-134-03452-3.
2	I. Nourbakhsh et al., *Robotics for Construction and Infrastructure*.
3	Oussama Khatib et al., *Springer Handbook of Robotics*, Springer, 2nd Edition, 2016, ISBN 978-3-319-32550-7.
4	*Recent Journal Articles and Conference Proceedings on Construction Robotics, Automation and Digital Construction*.
5	S. Li, S. Dragićević and X. Zhou, *Geospatial Big Data: Geospatial Data in a Changing World*, Springer, 1st Edition, 2015, ISBN 978-3-319-21773-5.
6	R. Pajarola and S. Sinha, *Geospatial Big Data Analytics*, CRC Press

Web links and Video Lectures (e–Resources)	
1	Google Earth Engine: https://earthengine.google.com
2	AWS Open Data Registry: https://registry.opendata.aws
3	Microsoft Planetary Computer: https://planetarycomputer.microsoft.com
4	NPTEL Cloud Computing: https://nptel.ac.in

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	Students identify and map IaaS, PaaS, SaaS for a given geospatial workflow.	24
	OR	
2	Draw a cloud-based workflow for satellite image ingestion, processing, and output generation.	24
	OR	
3	Write and explain queries for buffer, overlay, and spatial join in cloud geodatabase	24
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	Present a geospatial AI/cloud decision-support solution for smart city or sustainability use.	24
	OR	
2	Prepare and present a report on cloud-based flood monitoring, urban growth, or transport planning.	24

CO – PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2		2	2	
CO2	3	3		3	3	
CO3	3	3		3	3	
CO4	3	3	3	3	3	2
CO5	3	3	3	3	3	3

Semester: I						
Special Concrete						
Course Code	**:**	1MCV106I		**Credits**	**:**	3
Hours/Week (L: T: P)	**:**	42(3:0:0)		**CIE**	**:**	50Marks
Total Hours/Semester CI(L/T):LI(P):TW&SL	**:**	90(42:0:48)		**SEE**	**:**	50Marks
Course Type	**:**	PEC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Building materials and Concrete Technology
Knowledge on Fundamental Concepts	Material properties, Mix design
Knowledge on Connected Tools (If any)	NDT equipment's

Course Learning Objectives:	
CLO1	Explain different types and properties of special concrete.
CLO2	Select suitable methods to design special concrete with desired properties.
CLO3	Evaluate strength, durability, and shrinkage through laboratory tests.
CLO4	Examine applications of special concrete in construction and infrastructure.
CLO5	Describe recent developments in nanotechnology, smart concrete, and advanced materials.

Module – 1	**08Hrs**
Constituent materials: Role of constituents, Components of modern concrete, Rheology, Mineral and Chemical admixtures and their effect on properties of concrete. Special cements: Need, Classifications, Blended cements, modified hydraulic cements, calcium aluminate cements, calcium sulphate-based binders, calcium sulfo-aluminate cements, shrinkage compensating (or) expansive cements, macro defect-free cements, phosphate cements, fast setting cements, their Performance and prescriptive specifications, Methods of mix proportioning: IS method, ACI method and BS method **Text Book 1:** Ch.2, Appendix II & III	
Module – 2	**08Hrs**
Light Weight concrete: Introduction, classification, strength and elastic properties, durability, mix proportioning. **High density concrete:** Radiation shielding ability of concrete, materials for high density concrete, mix proportioning, properties in fresh and hardened state, placement methods. **Self-compacting Concrete(SCC):** General characteristics,Properties, microstructure. Robustness and methods of mix proportioning and applications. **Text Book 2:** Ch.12: 12.1, 12.2, 12.3, 12.9	
Module – 3	**08 Hrs**
Fibre reinforced concrete: Fibre materials, mix proportioning, distribution and orientation, interfacial bond, properties in fresh state, Toughness and impact resistance, Elastic modulus, creep, and drying shrinkage, strength and behavior in tension, compression and flexure, crack arrest and toughening mechanism, durability and applications. **Ferro cement:** Materials, mechanical properties, cracking of ferrocement, Types and methods of construction, strength and behavior in tension, compression and flexure, Design of ferrocement in tension, durability, and applications. **Text Book 2:** Ch.12: 12.6 **Text Book 4:** Ch.12.19	
Module – 4	**08 Hrs**
High strength concretes: Materials and mix proportion, Microstructure, stress-strain relation, fracture, drying shrinkage, and creep.	

Mass concrete and Roller compacted concrete: Constituents, mix proportioning, properties in fresh and hardened states, applications and limitations. **Different NDT techniques for performance evaluation of structures:** Rebound hammer, Ultrasonic pulse velocity meter, Profometer, Ground Penetrating Radar (GPR), Core test, Carbonation and Corrosion assessment. **Text Book 2:** Ch.12: 12.2, 12.11, 12.12, **Text Book 3:** Ch. 2: 2.1 to 2.6, Ch.3: 3.5 to 3.9, Ch.7: 7.1, 7.2
Module – 5 **08 Hrs**
Other concretes for special properties: High-volume fly ash concretes, geo-polymer concrete, pervious concrete, aerated concrete, ultrahigh performance concretes, Reactive powder concrete, Bacterial concrete, Heat resistant and refractory concrete. Their significance, materials, general consideration strength and durability aspects. Mixture proportioning and parameters in the development of Special concreting operations: Guniting and shot creting, pre- placed aggregate, anti-washout concretes, concrete pumping, Tremie placement for underwater applications. **Text Book 4:** Ch.12.1 ,12.22, 12.24, 12.6, 12.21, 12.15, 7.14, 7.13

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the principles of mix design and effects of additives, fibers, and curing on special concrete.
CO2	Apply mix design methods to develop special concrete with required strength and durability.
CO3	Interpret laboratory test results to evaluate the properties of special concrete.
CO4	Analyze special concrete based on strength, durability, and workability under specific conditions.
CO5	Evaluate quality control and troubleshooting during the production, transportation, and placement of special concrete.

Text Books	
1	A.M. Neville, Properties of Concrete, 5th Edition, Pearson Education, 2011, ISBN: 978-0-273-75580-7.
2	P. Kumar Mehta and Paulo J.M. Monteiro, Concrete: Microstructure, Properties, and Materials, 4th Edition, McGraw-Hill, 2014, ISBN: 978-0-071-79787-0.
3	J. Prasad and C.G. Krishnadas Nair, *Non-Destructive Testing and Evaluation of Materials*, 2nd Edition, Tata McGraw-Hill Education, 2011, ISBN**:** 978-0-070-70703-0**.**
4	M.S. Shetty and A.K. Jain, Concrete Technology: Theory and Practice, 8th Edition, S. Chand Publishing, 2022, ISBN: 978-93-5253-380-1.

Reference Books	
1	Andrew Short and William Kinniburgh, Lightweight Concrete, 3rd Edition, Applied Science Publishers, 1978, ISBN: 978-0-853-34734-7.
2	Pierre-Claude Aïtcin, High Performance Concrete, 1st Edition, E & FN Spon / CRC Press, 1998, ISBN: 978-0-419-19270-1.
3	M.R. Rixom and Noel P. Mailvaganam, Chemical Admixtures for Concrete, 3rd Edition, CRC Press, 1999, ISBN: 978-0-419-22520-1.

Web links and Video Lectures (e–Resources)	
1	https://www.sciencedirect.com/topics/engineering/special-concrete
2	https://www.youtube.com/watch?v=KHnFwnlCeZQ&pp=ygUWI3N1cGVyd29ya2FibGVj b25jcmV0ZQ%3D%3D
3	https://www.youtube.com/watch?v=RqnpEX-Sqg8
4	https://ecajmer.ac.in/facultylogin/announcements/upload/Unit-3(FRP%20&%20Ferrocement).pdf

TW (Term work): Includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No	**Term Work (TW)**	**NO. of Hrs/Sem**
1	**Assignment:** Study the mix design, properties and applications of lightweight concrete, high-density concrete and self-compacting concrete.	24
	OR	
2	**Mini Project/Case Study:** Study the materials, properties, mix proportioning and applications of any one special concrete such as FRC, ferrocement, high-strength, geopolymer or UHPC.	24
SL (Self Learning) Components: Includes NPTEL/MOOC modules, spoken tutorials, online educational resources etc.		
Sl. No	**Self-Learning (SL)**	**NO. of Hrs/Sem**
1	**NPTEL/MOOC:** Study special concrete materials, mix design, SCC, FRC and high-strength concrete.	24
	OR	
2	**Online Learning:** Study NDT techniques and recent concretes such as geopolymer, UHPC, bacterial and pervious concrete.	24

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	2	3	3	2
CO2	3	3				2
CO3	2	2	3	3		2
CO4	2	2	3			2
CO5	2	2	2			2

1MCVL107X: Professional Core Course Lab (PCCL)

Semester: I						
COMPUTATIONAL STRUCTURAL MODELING AND ANALYSIS LABORATORY						
Course Code	:	1MCVL107A		**Credits**	:	1
Teaching Hours/Week (L: T:P)	:	28(0: 0: 2)		**CIE**	:	50 Marks
Total Hours of Pedagogy L:T:P: TW&SL	:	30(0: 0:28:2)		**SEE**	:	50 Marks
Course Type	:	PCCL		**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	Structural Analysis, Strength of Materials
Knowledge on Fundamental Concepts	Basic knowledge of structural analysis, loads, reactions, forces and displacements
Knowledge on Connected Tools (If any)	Basic knowledge of structural analysis software and computer applications

Course Learning Objectives: This course will enable the students to	
CLO1	Describe structural modeling concepts and software tools for structural analysis.
CLO2	Apply computational methods to analyze beams, trusses and frames.
CLO3	Analyze structural responses such as forces, moments, stresses and displacements.
CLO4	Develop computational models for structural systems using analysis software.
CLO5	Evaluate computational results and prepare structural analysis reports.

PRACTICAL COMPONENTS (LI-28Hrs)

PART -A FIXED EXPERIMENTS

1. Introduction to structural analysis software interface, model creation, units, material properties, supports, and load assignment. (CO1)
2. Modeling and analysis of simply supported and cantilever beams under point load, UDL, and varying load conditions. (CO1, CO2)
3. Structural analysis of pin-jointed trusses under different loading patterns and evaluation of member forces. (CO2, CO3)
4. Modeling and analysis of plane frames for reactions, internal force diagrams, and displacement response. (CO2, CO3, CO4)
5. Computation of bending moment, shear force, and deflection for beams using finite element or matrix methods. (CO2, CO3)
6. Analysis of continuous beams and rigid frames for support reactions, moment distribution, and load effects. (CO2, CO3, CO4)
7. Modeling and analysis of two-way slab or floor system subjected to gravity loading. (CO3, CO4)
8. Comparison of analytical and computational results for a selected structural system and interpretation of discrepancies. (CO4, CO5).

PART-B OPENENDED EXPERIMENTS

1. Develop a complete computational model for a multi-bay frame subjected to dead and live loads and interpret design-critical output. (CO2, CO4, CO5)
2. Modify boundary conditions and load combinations for a given structural system and study the sensitivity of results. (CO2, CO3, CO5)
3. Prepare a simulation-based workflow for analyzing a steel truss or roof system and report governing member forces. (CO3, CO4, CO5)
4. Design and analyze an irregular building frame and identify critical displacement and force response zones. (CO3, CO4, CO5)

5. Create a comparative study of beam or frame behavior using different support conditions, materials, or member sections. (CO2, CO4, CO5) 6. Generate a complete computational structural analysis report including modeling assumptions,results, interpretation, and engineering recommendations. (CO3, CO4, CO5)

Course Outcomes: After completing the course, the students will be able to	
CO1	Develop and use structural modeling software tools to create geometry, assign materials, supports, and load cases for structural systems.
CO2	Analyze structural components and systems using linear static analysis for typical loading conditions.
CO3	Interpret analysis results such as reactions, shear force, bending moment, stress, displacement, and stability indicators.
CO4	Model and evaluate structural behavior of beams, trusses, frames, and slabs using computational tools for civil engineering applications.
CO5	Formulate and solve real-world structural engineering problems through simulation-based workflows and report the results effectively

Text Books	
1	William McGuire, Richard H. Gallagher and Ronald D. Ziemian, *Matrix Structural Analysis***,** Wiley, 2nd Edition, 1999, ISBN 978-0-471-12918-9.
2	Russell C. Hibbeler, *Structural Analysis*, Pearson, 11th Edition, 2023, ISBN 978-0-13-802625-7. The current Pearson listing identifies the 11th edition as the latest edition.
3	Robert D. Cook, David S. Malkus, Michael E. Plesha and Robert J. Witt, *Concepts and Applications of Finite Element Analysis***,** Wiley, 4th Edition, 2001, ISBN 978-0-471-35605-9.
4	Relevant Structural Analysis Software User Manual, Publisher: Software Developer

Reference Books	
1	Amin Ghali, A. M. Neville and Thomas G. Brown, *Structural Analysis: A Unified Classical and Matrix Approach***,** CRC Press, 7th Edition, 2017, ISBN 978-1-4987-2506-4.
2	R. L. Jindal, *Structural Analysis*, S. Chand Publishing, 4th Edition, 2013, ISBN: Not Specified.
3	C. K. Wang**,** *Indeterminate Structural Analysis***,** McGraw-Hill, 1st Edition, 1983, ISBN: Not Specified.
4	Bureau of Indian Standards, *IS 800:2007 – General Construction in Steel – Code of Practice*

Web links and Video Lectures (e–Resources)	
1	MIT OpenCourseWare: Free course materials, lecture notes, and videos on structural analysis and finite element methods.
2	OpenSees official resources and tutorials: command manual, examples, and workshop/tutorial materials for structural simulation.
3	NPTEL courses on structural analysis, finite element methods, and computational mechanics.
4	Online tutorials for open-source structural analysis tools such as OpenSeesPy, Pynite, and browser-based structural analysis applications.
5	IS 800:2007 and IS 456:2000 online reference materials for steel and reinforced concrete analysis and design practice.

CO – PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3				3	
CO2	3	3		2	3	
CO3	3	3		3	3	
CO4	3	3	2	2	3	
CO5	3	3	3	3	3	

Semester: I						
BIM-BASED PLANNING AND SCHEDULING LABORATORY						
Course Code	**:**	1MCVL107B		**Credits**	**:**	1
Teaching Hours/Week (L: T:P)	**:**	28(0: 0: 2)		**CIE**	**:**	50 Marks
Total Hours of Pedagogy L:T:P: TW&SL	**:**	30(0: 0:28:2)		**SEE**	**:**	50 Marks
Course Type	**:**	PCCL		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Construction Planning and Management, BIM
Knowledge on Fundamental Concepts	Basic knowledge of construction planning, scheduling, WBS, CPM and project control
Knowledge on Connected Tools (If any)	Basic knowledge of Primavera P6/MS Project, BIM software and 4D simulation tools

Course Learning Objectives: This course will enable the students to	
CLO1	Describe construction planning, scheduling and BIM-based project control concepts.
CLO2	Apply WBS, scheduling and resource planning techniques using planning tools.
CLO3	Develop 4D BIM models by linking construction schedules with BIM elements.
CLO4	Analyze critical paths, resources, site logistics, progress and delays using digital tools.
CLO5	Prepare schedules, 4D outputs, progress reports and coordination documents.

	LIST OF EXPERIMENTS	**LI-28 Hrs**
1	Construction Planning and BIM/VDC Basics: Roles of planning/BIM engineers, project stages, construction methods, baseline scheduling, and project control concepts.	
2	Planning Tool Setup (Primavera/MS Project): Project calendars, WBS/OBS, activity coding, milestones, constraints, and baseline creation.	
3	WBS and Location-Based Planning: Development of WBS using floors, zones, chainages, and work packages aligned with 4D model breakdown.	
4	Scheduling Techniques: Gantt charts and network diagrams, activity sequencing, CPM, critical path, float, milestones, and logic checks.	
5	Resource Planning: Labour, materials, equipment, productivity, procurement lead times, resource loading, and basic levelling.	
6	4D BIM Model Preparation: Model federation, element classification, IFC/openBIM basics, and schedule–model mapping.	
7	4D BIM Simulation: Linking schedules with models using tools like Synchro/Navisworks to simulate construction sequences.	
8	Site Logistics and Constructability: Planning of cranes, access, storage, safety zones, temporary works,	
9	Progress Tracking and Control: Updating schedules, tracking progress, baseline comparison, delay analysis, and recovery planning.	
10	Reporting and Communication: Schedule reports, 4D visuals, dashboards, CDE-based coordination, and professional reporting..	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand construction planning, scheduling, project controls, and BIM/VDC workflows used during construction execution.
CO2	Develop WBS/location-based work packages and prepare construction schedules using Primavera P6, MS Project, or equivalent planning tools.

CO3	Link schedules with BIM model elements and create 4D construction simulations using Synchro, Navisworks, Fuzor, or equivalent tools.
CO4	Analyze critical path, dependencies, resources, site logistics, progress updates, delays, and recovery alternatives.
CO5	Prepare baseline/revised schedules, 4D outputs, progress reports, issue views, and coordination

Text Books	
1	Willem Kymmell, Building Information Modeling: Planning and Managing Construction Projects with 4D CAD and Simulations, McGraw-Hill Professional, 1st Edition, 2008, ISBN 978-0-07-149453-3.
2	Brad Hardin and Dave McCool, BIM and Construction Management: Proven Tools, Methods, and Workflows, John Wiley & Sons, 2nd Edition, 2015, ISBN 978-1-118-94276-5.
3	K. K. Chitkara, Construction Project Management: Planning, Scheduling and Controlling, McGraw-Hill Education, 4th Edition, 2019, ISBN 978-93-5316-627-4.
4	Andrew Baldwin and David Bordoli, A Handbook for Construction Planning and Scheduling, John Wiley & Sons, 1st Edition, 2014, ISBN 978-0-470-67032-3.

Reference Books	
1	Rafael Sacks, Charles Eastman, Ghang Lee and Paul Teicholz, BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers, John Wiley & Sons, 3rd Edition, 2018, ISBN 978-1-119-28753-7.
2	Royal Institution of Chartered Surveyors (RICS), BIM for Project Managers, RICS, Not Applicable, 2017, ISBN Not Applicable.
3	European Federation of Engineering Consultancy Associations (EFCA), BIM and ISO 19650 from a Project Management Perspective, EFCA, 1st Edition, 2019, ISBN 978-9-07-508507-5.
4	Relevant software manuals/user guides for Primavera P6, MS Project, Synchro, Navisworks, Fuzor, Trimble, VisiLean, Revizto, Plannerly and CDE platforms, respective software publishers

Web links and Video Lectures (e–Resources)	
1	NPTEL courses on construction planning, scheduling, construction management, and project control.
2	NPTEL / SWAYAM / institutional resources on BIM, VDC, 4D BIM, lean construction, and digital construction workflows.
3	Software learning resources for Primavera P6/MS Project, Synchro/Navisworks/Fuzor or equivalent 4D simulation tools.
4	Tool-demonstration resources on Fuzor, VisiLean, Trimble, Revizto, Plannerly, CDE platforms, reality capture, and digital twin workflows, used only as workflow examples.
5	OpenBIM and information management resources covering IFC, BCF, model federation, CDE workflows, and schedule/model exchange.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3				2	
CO2	3	3			3	
CO3	3	3	2		3	
CO4	3	3	2	2	3	
CO5	3	3	3	2	3	

Semester: I						
GIS-BASED ALIGNMENT AND TRAFFIC ANALYTICS						
Course Code	:	1MCVL107C		**Credits**	:	1
Teaching Hours/Week (L: T:P)	:	28(0: 0: 2)		**CIE**	:	50 Marks
Total Hours of Pedagogy L: T:P: TW&SL	:	30(0: 0:28:2)		**SEE**	:	50 Marks
Course Type	:	PCCL		**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	Engineering Surveying, Transportation Engineering, GIS and Remote Sensing
Knowledge on Fundamental Concepts	Basic knowledge of surveying, road alignment, traffic flow and GIS
Knowledge on Connected Tools (If any)	Basic knowledge of GIS software, spatial data and traffic analysis tools

Course Learning Objectives: This course will enable the students to	
CLO1	Describe GIS concepts and their applications in road alignment and traffic analysis.
CLO2	Apply GIS tools to analyze horizontal and vertical road alignment.
CLO3	Analyze traffic flow, corridor performance and network characteristics using GIS.
CLO4	Evaluate road safety, traffic impact and alternative alignments using geospatial methods.
CLO5	Develop GIS-based solutions for alignment and traffic planning and prepare technical reports.

	PART- A FIXED EXPERIMENTS	**LI-28 Hrs**
1	Introduction to GIS software interface, creation of project workspace, map layers, coordinate systems, and data import for road alignment and traffic studies.	
2	Digitization of road centerline, control points, and basic horizontal alignment using GIS tools.	
3	Preparation of elevation profile and vertical alignment using terrain data and road geometry.	
4	Mapping and analysis of traffic volume data, turning movements, and corridor flow patterns.	
5	GIS-based road safety analysis using sight distance, curve consistency, and hazardous location identification.	
6	Traffic impact analysis of a selected corridor or junction using spatial and demand data.	
7	Comparison of alternative road alignments based on length, terrain constraint, land-use impact, and traffic performance.	
8	Preparation of a GIS-based technical report with maps, tables, results, interpretation, and recommendations.	
	PART-B OPEN ENDED EXPERIMENTS	
1	Develop a GIS-based model for a new road bypass and evaluate its effect on through traffic and local access.	
2	Create a comparative study of two alternative alignments for a corridor using terrain, land use, and traffic indicators.	
3	Analyse a road junction using GIS and identify possible geometric or traffic control	

	improvements.
4	Perform a corridor traffic sensitivity study for changes in demand, access points, or development intensity.
5	Prepare a road safety hotspot map using accident, alignment, and traffic data.
6	Generate a complete GIS-based alignment and traffic analytics report including modelling assumptions, results, interpretation, and engineering recommendations.

Course Outcomes: After completing the course, the students will be able to	
CO1	Develop GIS-based road alignment and traffic analysis models using spatial and traffic datasets.
CO2	Analyse horizontal and vertical alignment characteristics using GIS and related software tools.
CO3	Interpret traffic flow, corridor performance, and network characteristics using GIS-based analytics.
CO4	Evaluate road safety, traffic impact, and alignment consistency using geospatial methods.
CO5	Formulate and solve real-world alignment and traffic planning problems through simulation-based GIS workflows and report the results effectively.

Text Books	
1	Harvey J. Miller and Shih-Lung Shaw, Geographic Information Systems for Transportation: Principles and Applications, Oxford University Press, 1st Edition, 2001, ISBN 978-0-19-512394-4. 2001 edition.
2	David A. Hensher, Kenneth J. Button, Kingsley E. Haynes and Peter R. Stopher, Handbook of Transport Geography and Spatial Systems, Emerald Group Publishing Limited/Elsevier, 1st Edition, 2004, ISBN 978-0-08-044108-5.
3	Information Resources Management Association, Geographic Information Systems: Concepts, Methodologies, Tools, and Applications, IGI Global, 1st Edition, 2013, ISBN 978-1-4666-2038-4.
4	M. A. Rahman and R. B. Singh, Traffic Engineering and Transportation Planning, Alpha Science International, 1st Edition, 2016, ISBN Not Verified.
5	S. K. Khanna and C. E. G. Justo, Highway Engineering, Nem Chand & Bros., 10th Edition, 2017, ISBN 978-81-85240-93-0.
6	James B. Campbell and Randolph H. Wynne, Introduction to Remote Sensing, Guilford Press, 5th Edition, 2011, ISBN 978-1-60918-176-5..
7	M. Anji Reddy, Textbook of Remote Sensing and Geographical Information Systems, B.S. Publications, 4th Edition, 2018
Reference Books	
1	Esri, ArcGIS Pro Network Analyst Documentation, Esri, Latest Edition, 2026
2	Paul A. Zandbergen, Python Scripting for ArcGIS Pro, Esri Press, 2nd Edition, 2023, ISBN 978-1-58948-750-2.
3	T. Subramani and D. Pari, Highway Alignment Using Geographical Information System, IOSR Journal of Engineering, 1st Edition, 2015.

Web links and Video Lectures (e–Resources)	
1	MIT OpenCourseWare: Free course materials, lecture notes, and videos on structural analysis and finite element methods.
2	OpenSees official resources and tutorials: command manual, examples, and workshop/tutorial materials for structural simulation.
3	NPTEL courses on structural analysis, finite element methods, and computational mechanics.
4	Online tutorials for open-source structural analysis tools such as OpenSeesPy, Pynite, and browser-based structural analysis applications.
5	IS 800:2007 and IS 456:2000 online reference materials for steel and reinforced concrete analysis and design practice.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2			3	
CO2	3	3		2	3	
CO3	3	3		3	3	
CO4	3	3	2	3	3	2
CO5	3	3	3	3	3	3

Semester: I						
GEOTECHNICAL ENGINEERING STUDIO						
Course Code	:	1MCVL107D		**Credits**	:	1
Teaching Hours/Week (L: T:P)	:	28(0: 0: 2)		**CIE**	:	50 Marks
Total Hours of Pedagogy L: T:P: TW&SL	:	30(0: 0:28:2)		**SEE**	:	50 Marks
Course Type	:	PCCL		**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	Geotechnical Engineering, Engineering Geology
Knowledge on Fundamental Concepts	Basic knowledge of soil properties, classification, compaction, permeability, shear strength and foundations
Knowledge on Connected Tools (If any)	Basic knowledge of laboratory testing equipment, Excel and geotechnical analysis tools

Course Learning Objectives: This course will enable the students to	
CLO1	Describe basic soil properties and standard geotechnical laboratory tests.
CLO2	Apply soil classification and laboratory testing methods for engineering applications.
CLO3	Analyze compaction, permeability, consolidation and shear strength characteristics of soils.
CLO4	Evaluate soil parameters for foundations, retaining systems and slope stability.
CLO5	Develop practical geotechnical solutions and prepare technical reports using laboratory data.

	PART- A FIXED EXPERIMENTS	**LI-28 Hrs**
1	Determination of water content, specific gravity, and grain size distribution of soil sample.	
2	Determination of Atterberg limits and soil classification using IS/standard system.	
3	Standard Proctor compaction test and determination of optimum moisture content and maximum dry density. (CO2, CO3)	
4	Laboratory permeability test on sandy soil and evaluation of coefficient of permeability.	
5	Direct shear test on cohesionless/cohesive soil and determination of shear strength parameters.	
6	Unconfined compression test on cohesive soil and interpretation of strength characteristics.	
7	One-dimensional consolidation test and estimation of compression index, coefficient of consolidation, and settlement behavior.	
8	California Bearing Ratio test and evaluation of subgrade strength for pavement applications.	
	PART-B OPEN ENDED EXPERIMENTS	
1	Develop a complete geotechnical investigation workflow for a proposed site, including sampling, testing plan, and soil profile interpretation.	
2	Prepare a design-based comparison of shallow foundation options using soil test data and select the most suitable footing type.	
3	Analyze settlement and bearing capacity for a given foundation using laboratory-	

	derived soil parameters and recommend safe foundation pressure.
4	Evaluate the stability of an earth slope using shear strength data and propose suitable improvement measures.
5	Develop a design note for a retaining wall or basement support system using geotechnical parameters obtained from laboratory tests.
6	Prepare a comprehensive geotechnical report for a real or simulated project site, including test results, design interpretation, and engineering recommendations.
7	Study the effect of groundwater condition on soil behavior and foundation performance using available field/laboratory data.

Course Outcomes: After completing the course, the students will be able to	
CO1	Perform standard geotechnical laboratory tests to determine index and engineering properties of soils.
CO2	Interpret test results and classify soil behavior for engineering applications.
CO3	Analyze compaction, permeability, consolidation, and shear strength characteristics of soils.
CO4	Design and evaluate geotechnical parameters for foundations, earth retaining systems, and slope-related problems.
CO5	Apply laboratory and design data to develop practical geotechnical solutions and prepare technical reports.

Text Books	
1	Braja M. Das, Principles of Geotechnical Engineering, Cengage Learning, 10th Edition, 2022, ISBN 978-0-357-42047-8.
2	Jonathan Knappett and R. F. Craig, Craig's Soil Mechanics, CRC Press, 9th Edition, 2020, ISBN 978-1-138-07006-6.
3	Muni Budhu, Soil Mechanics and Foundations, John Wiley & Sons, 3rd Edition, 2011, ISBN 978-0-470-55684-9.
Reference Books	
1	K. H. Head and R. J. Epps, Manual of Soil Laboratory Testing, Whittles Publishing, 3rd Edition, 2011, ISBN 978-1-904445-69-2.
2	T. William Lambe and Robert V. Whitman, Soil Mechanics, John Wiley & Sons, 1st Edition, 1969, ISBN 978-0-471-51192-2.
3	Braja M. Das and Khaled Sobhan, Principles of Geotechnical Engineering, Cengage Learning, 9th Edition, 2018, ISBN 978-1-305-97093-9.
Code / Standard	
1	IS 2720 (relevant parts for moisture content, specific gravity, grain size analysis, Atterberg limits, permeability, compaction, shear, consolidation, and CBR).
2	IS 1892 for site investigation, IS 2131 for SPT, and related investigation codes for design-oriented studio problem.

Web links and Video Lectures (e–Resources)	
1	Web E-Resources
2	NPTEL course on Geotechnical Engineering Laboratory.
3	IIT Bombay geotechnical lab manual and experiment sheets.
4	Indian Standard test method references under IS 2720 series and related investigation codes.
5	Online lecture materials and video demonstrations on soil testing and geotechnical properties from academic repositories.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2		2	3	
CO2	3	3		3	3	
CO3	3	3		3	3	
CO4	3	3	3	3	3	2
CO5	3	3	3	3	3	3

Semester: I						
HYDRAULIC AND WASTEWATER NETWORK MODELING LABORATORY						
Course Code	:	1MCVL107E		**Credits**	:	1
Teaching Hours/Week (L: T:P)	:	28(0: 0: 2)		**CIE**	:	50 Marks
Total Hours of Pedagogy L: T:P: TW&SL	:	30(0: 0:28:2)		**SEE**	:	50 Marks
Course Type	:	PCCL		**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	Fluid Mechanics, Water Supply Engineering, Wastewater Engineering
Knowledge on Fundamental Concepts	Basic knowledge of fluid flow, water distribution, sewer systems and hydraulic principles
Knowledge on Connected Tools (If any)	Basic knowledge of EPANET, hydraulic modeling software and Excel

Course Learning Objectives: This course will enable the students to	
CLO1	Describe hydraulic and wastewater network modeling concepts and software tools.
CLO2	Apply demand, flow, pressure and boundary conditions to water and wastewater network models.
CLO3	Analyze pipe sizing, head losses, hydraulic grade lines and network performance.
CLO4	Evaluate water supply and wastewater network alternatives using hydraulic modeling.
CLO5	Develop practical network solutions and prepare technical reports using model outputs.

	PART- A FIXED EXPERIMENTS	**LI-28 Hrs**
1	Introduction to hydraulic and wastewater network modeling software; creation of project, unit settings, node/pipe database, and basic map/geometric setup.	
2	Preparation of water distribution network layout and assignment of demand patterns, elevations, and boundary conditions.	
3	Simulation of steady-state flow in a water supply network and interpretation of discharge, pressure, velocity, and head loss results.	
4	Analysis of pipe diameter effects on pressure distribution and pumping requirement in a water distribution system.	
5	Modeling of a branched and looped water supply network and comparison of hydraulic performance.	
6	Simulation of a wastewater sewer network and evaluation of flow, depth, slope, and self-cleansing criteria.	
7	Hydraulic grade line and energy grade line plotting for a selected network scenario and interpretation of critical sections.	
8	Sensitivity study on demand variation, pipe roughness, or node elevation and its effect on network performance.	
	PART-B OPEN ENDED EXPERIMENTS	
1	Develop a hydraulic model for a small-town water supply network and recommend optimal pipe sizes and pressures.	

2	Prepare a wastewater network model for a residential layout and identify critical sewer reaches requiring redesign.
3	Compare two network alternatives for water distribution based on cost, pressure adequacy, and energy requirement.
4	Analyze the effect of fire demand or peak hourly demand on a municipal water network and propose improvements.
5	Develop a design note for a pumping main or sewer main using model outputs and engineering assumptions.
6	Prepare a comprehensive network design report for a campus or locality including assumptions, model data, results, and recommendations.
7	Evaluate the impact of pipe roughness deterioration, leakage, or blockage on hydraulic performance and suggest mitigation measures.

Course Outcomes: After completing the course, the students will be able to	
CO1	Prepare and model hydraulic and wastewater network systems using suitable software tools.
CO2	Interpret demand, flow, pressure, and hydraulic grade line behavior in distribution and sewer networks.
CO3	Analyze pipe sizing, node demands, head losses, and operational constraints for network performance.
CO4	Design and evaluate water supply and wastewater network alternatives for engineering applications.
CO5	Apply modeling outputs to prepare technical reports and recommend practical network

Text Books	
1	Larry W. Mays, Water Distribution Systems Handbook, McGraw-Hill, 1st Edition, 2000, ISBN 978-0-07-134213-1.
2	Thomas M. Walski, Donald V. Chase, Dragan A. Savic, Walter Grayman, Stephen Beckwith and Gregory Koelle, Advanced Water Distribution Modeling and Management, Haestad Press, 1st Edition, 2003, ISBN 978-0-9714141-0-6.
3	Metcalf & Eddy, Wastewater Engineering: Treatment and Resource Recovery, McGraw-Hill Education, 5th Edition, 2014, ISBN 978-0-07-340118-8.
4	B. C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, Water Supply Engineering, Laxmi Publications, 2nd Edition, 2016, ISBN 978-81-318-0910-5.
Reference Books	
1	S. K. Garg, Environmental Engineering: Water Supply Engineering, Khanna Publishers, 24th Edition, 2022, ISBN 978-81-7409-307-3.
2	Central Public Health and Environmental Engineering Organisation, Manual on Water Supply and Treatment, Ministry of Housing and Urban Affairs, 4th Edition, 1999.
3	Central Public Health and Environmental Engineering Organisation, Manual on Sewerage and Sewage Treatment Systems, Ministry of Housing and Urban Affairs, 2nd Edition, 2013
Lab manuals:	
1	EPANET Development Team, EPANET 2.2 User Manual, United States Environmental Protection Agency, Latest Edition, 2020.
2	American Water Works Association, Water Distribution System Modeling and Laboratory Resources, AWWA
3	NPTEL, Water Supply and Wastewater Engineering Laboratory Resources, NPTEL/IITs

Web links and Video Lectures (e–Resources)	
1	EPANET – US EPA — public-domain software and official learning source for

	pressurized water distribution network modeling, hydraulic simulation, and water quality analysis.
2	OpenWasteWater — open-source resource for wastewater treatment plant modeling with OpenModelica, useful for conceptual and computational understanding of wastewater systems.
3	AWWA eLearning Course Catalog — online tutorial and professional learning resources related to EPANET and water distribution system design.
4	Autodesk Hydraulic Modeling Resources — free learning series and videos for hydraulic modeling, GIS-based workflows, and stormwater/water network applications.
5	Free Online Course: Hydraulic Modeling with HEC-RAS — useful for supplementing hydraulic concepts and simulation practice.
6	Hydraulic Modeling Resources – Fluidit — collection of hydraulic modeling references, papers, and learning material on pipe network analysis.
7	Wastewater treatment modelling overview — useful overview of wastewater modeling platforms and comparison of available tools.
8	QSDsan platform paper — open-source sanitation and resource recovery modeling platform relevant to advanced wastewater system studies.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2			3	
CO2	3	3		2	3	
CO3	3	3	2	3	3	2
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

Semester: I						
WATERSHED AND IRRIGATION NETWORK MODELING LABORATORY						
Course Code	:	1MCVL107F		**Credits**	:	1
Teaching Hours/Week (L: T:P)	:	28(0: 0: 2)		**CIE**	:	50 Marks
Total Hours of Pedagogy L: T:P: TW&SL	:	30(0: 0:28:2)		**SEE**	:	50 Marks
Course Type	:	PCCL		**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	Hydrology, Irrigation Engineering, Fluid Mechanics
Knowledge on Fundamental Concepts	Watershed, rainfall-runoff, irrigation, flow and hydraulic systems
Knowledge on Connected Tools (If any)	HEC-HMS, EPANET, SWMM, QGIS and Python

Course Learning Objectives: This course will enable the students to	
CLO1	Describe watershed and irrigation network modeling concepts and software tools.
CLO2	Apply rainfall, watershed and network parameters for modeling runoff and irrigation systems.
CLO3	Analyze runoff, discharge, pipe/canal sizing, head losses and network performance
CLO4	Evaluate watershed and irrigation network alternatives using modeling results.
CLO5	Prepare technical reports and recommend practical solutions using model outputs.

	PART- A FIXED EXPERIMENTS	**LI-28 Hrs**
1	Introduction to watershed and irrigation network modeling software; creation of project, unit settings, watershed/canal database, and basic map or geometric setup.	
2	Preparation of watershed boundary, sub-catchment layout, and assignment of rainfall, soil, slope, and land-use parameters.	
3	Simulation of runoff generation for a selected rainfall event and interpretation of discharge, peak flow, infiltration, and storage behavior.	
4	Analysis of canal or pipeline sizing effects on discharge distribution, water level, and pumping/flow requirements in an irrigation network.	
5	Modeling of branched and looped irrigation distribution networks and comparison of hydraulic performance.	
6	Simulation of watershed drainage or farm conveyance network and evaluation of flow, depth, slope, and operational criteria.	
7	Hydraulic grade line and water surface profile plotting for a selected watershed or irrigation network scenario and interpretation of critical sections.	
8	Sensitivity study on rainfall variation, canal roughness, or node elevation and its effect on network performance.	
	PART-B OPEN ENDED EXPERIMENTS	
1	Develop a watershed model for a small catchment and recommend suitable runoff mitigation measures.	
2	Prepare an irrigation network model for a command area and identify critical reaches requiring redesign.	
3	Compare two network alternatives for irrigation distribution based on cost, water	

	adequacy, and energy requirement.
4	Analyze the effect of peak rainfall or peak irrigation demand on a watershed-network system and propose improvements.
5	Develop a design note for a canal, pipeline, or storage structure using model outputs and engineering assumptions.
6	Prepare a comprehensive network design report for a watershed, campus, or locality including assumptions, model data, results, and recommendations.

Course Outcomes: After completing the course, the students will be able to	
CO1	Prepare watershed and irrigation network models using suitable software tools.
CO2	Interpret runoff, discharge, pressure, water level, and hydraulic behavior in watershed and irrigation systems.
CO3	Analyze canal/pipe sizing, node demands, head losses, and operational constraints for network performance.
CO4	Design and evaluate watershed and irrigation network alternatives for engineering applications.
CO5	Apply modeling outputs to prepare technical reports and recommend practical system

Text Books	
1	Larry W. Mays, Water Resources Engineering, Wiley, 3rd Edition, 2019, ISBN: 978-1-119-49057-9**.**
2	Thomas M. Walski, Donald V. Chase, Dragan A. Savic, Walter Grayman, Stephen Beckwith and Edmundo Koelle, Advanced Water Distribution Modeling and Management**,** Haestad Press, 1st Edition**,** 2003, ISBN: 978-0-9714141-2-9**.**
3	Metcalf & Eddy, Inc., George Tchobanoglous, H. David Stensel, Ryujiro Tsuchihashi and Franklin L. Burton, Wastewater Engineering: Treatment and Resource Recovery, McGraw-Hill Education, **5th Edition**, 2014, ISBN: 978-0-07-340118-8**.**
4	B. C. Punmia, B. B. Lal, Ashok Kumar Jain and Arun Kumar Jain**,** Irrigation and Water Power Engineering, Laxmi Publications, 16th Edition, 2014, ISBN: 978-81-318-0763-7
Reference Books	
1	S. K. Garg**,** Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 35th Revised Edition, 2019, ISBN: 978-81-7409-047-8**.**
2	S. K. Garg, Environmental Engineering – Volume I: Water Supply Engineering, Khanna Publishers, 37th Edition, 2024, ISBN: 978-81-7409-120-8.
3	Central Public Health and Environmental Engineering Organisation (CPHEEO**),** Manual on Water Supply and Treatment**,** Ministry of Urban Development, Government of India**,** 3rd Edition – Revised and Updated**,** 1999,
4	Central Public Health and Environmental Engineering Organisation (CPHEEO), Manual on Sewerage and Sewage Treatment Systems**,** Ministry of Housing and Urban Affairs, Government of India, Relevant Edition, 2013,
Lab manuals:	
1	Watershed and irrigation network modeling lab manual from reputed engineering institutions.
2	Watershed and irrigation network modeling experiment sheets.

Web links and Video Lectures (e–Resources)	
1	EPANET official page and user manual.
2	HEC-HMS documentation and downloads.
3	SWMM reference manual.
4	QGIS resources and training material.
5	Python documentation.
6	YouTube lectures on HEC-HMS, HEC-RAS, and watershed modeling.
7	ArcGIS watershed and water-network tutorial

8	Hydraulic Modeling Resources – Fluidit — collection of hydraulic modeling references, papers, and learning material on pipe network analysis.
9	Wastewater treatment modelling overview — useful overview of wastewater modeling platforms and comparison of available tools.
10	QSDsan platform paper — open-source sanitation and resource recovery modeling platform relevant to advanced wastewater system studies.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2			3	
CO2	3	3		2	3	
CO3	3	3	2	3	3	2
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

Semester: I						
BIM FOR BUILDINGS AND INFRASTRUCTURE MODELING LABORATORY						
Course Code	:	1MCVL107G		**Credits**	:	1
Teaching Hours/Week (L: T:P)	:	28(0: 0: 2)		**CIE**	:	50 Marks
Total Hours of Pedagogy L: T:P: TW&SL	:	30(0: 0:28:2)		**SEE**	:	50 Marks
Course Type	:	PCCL		**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	BIM, Construction Technology, Engineering Drawing
Knowledge on Fundamental Concepts	BIM, 3D modelling, building components and construction planning
Knowledge on Connected Tools (If any)	Revit, Navisworks, Civil 3D and BIM tools

Course Learning Objectives: This course will enable the students to	
CLO1	Describe BIM concepts and digital modeling workflows for buildings and infrastructure.
CLO2	Apply BIM tools to create and manage building and infrastructure models.
CLO3	Analyze model elements, clashes, quantities and design coordination issues.
CLO4	Develop coordinated BIM workflows for buildings and infrastructure projects.
CLO5	Prepare BIM-based reports, schedules and design recommendations.

	PART- A FIXED EXPERIMENTS	**LI-28 Hrs**
1	Introduction to watershed and irrigation network modeling software; creation of project, unit settings, watershed/canal database, and basic map or geometric setup.	
2	Preparation of watershed boundary, sub-catchment layout, and assignment of rainfall, soil, slope, and land-use parameters.	
3	Simulation of runoff generation for a selected rainfall event and interpretation of discharge, peak flow, infiltration, and storage behavior.	
4	Analysis of canal or pipeline sizing effects on discharge distribution, water level, and pumping/flow requirements in an irrigation network.	
5	Modeling of branched and looped irrigation distribution networks and comparison of hydraulic performance.	
6	Simulation of watershed drainage or farm conveyance network and evaluation of flow, depth, slope, and operational criteria.	
7	Hydraulic grade line and water surface profile plotting for a selected watershed or irrigation network scenario and interpretation of critical sections.	
8	Sensitivity study on rainfall variation, canal roughness, or node elevation and its effect on network	
	PART-B OPEN ENDED EXPERIMENTS	
1	Develop a watershed model for a small catchment and recommend suitable runoff mitigation measures.	
2	Prepare an irrigation network model for a command area and identify critical reaches requiring redesign.	

3	Compare two network alternatives for irrigation distribution based on cost, water adequacy, and energy requirement.
4	Analyze the effect of peak rainfall or peak irrigation demand on a watershed-network system and propose improvements.
5	Develop a design note for a canal, pipeline, or storage structure using model outputs and engineering assumptions.
6	Prepare a comprehensive network design report for a watershed, campus, or locality including assumptions, model data, results, and recommendations.

Course Outcomes: After completing the course, the students will be able to	
CO1	Prepare BIM-based digital models for buildings and infrastructure components using suitable software tools.
CO2	Interpret geometric, spatial, and data-linked model elements for planning and coordination.
CO3	Analyze clashes, quantities, and design consistency across architectural, structural, and infrastructure components.
CO4	Develop coordinated BIM workflows for buildings and infrastructure modeling applications.
CO5	Apply BIM outputs to prepare technical reports, schedules, and actionable design recommendations.

Text Books	
1	Rafael Sacks, Charles Eastman, Ghang Lee and Paul Teicholz, BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers**,** John Wiley & Sons, 3rd Edition, 2018, ISBN: 978-1-119-28753-7**.**
2	Eddy Krygiel and Brad Nies, Green BIM: Successful Sustainable Design with Building Information Modeling**,** Wiley/Sybex**,** 1st Edition, 2008**,** ISBN: 978-0-470-23960-5.
3	Brad Hardin and Dave McCool, BIM and Construction Management: Proven Tools, Methods, and Workflows, John Wiley & Sons, 2nd Edition, 2015**,** ISBN: 978-1-118-94276-5**.**
4	André Borrmann, Markus König, Christian Koch and Jakob Beetz, Building Information Modeling: Technology Foundations and Industry Practice, Springer, 1st Edition, 2018,
Reference Books	
1	Autodesk and other official BIM software learning guides**,** Autodesk BIM Learning Resources, Autodesk, Latest Edition**,** 2026**.**
2	Relevant national and international BIM standards and model coordination guidelines, BIM Standards and Model Coordination Guidelines**,** Relevant Standards Organizations, Latest Edition**,** 2026**.**
3	Publications on digital engineering, infrastructure BIM, and construction information management, Digital Engineering, Infrastructure BIM and Construction Information Management Publications**,** Various Publishers, Latest Edition**,** 2026**,**
4	Autodesk and other official BIM software learning guides, Autodesk BIM Learning Resources**,** Autodesk, Latest Edition**,** 2026**.**
Lab manuals:	
1	BIM laboratory manual from reputed engineering institutions.
2	Building and infrastructure modeling experiment sheets.
3	Online practice resources on BIM workflows, model coordination, and digital delivery.

Web links and Video Lectures (e–Resources)	
1	Autodesk BIM learning resources.
2	National and international BIM standards documentation.
3	Open educational resources on Revit, Navisworks, Civil 3D, and related platforms.
4	Video lectures on BIM workflows, clash detection, and model-based delivery.

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3				3	
CO2	3	3			3	
CO3	3	3	2	2	3	
CO4	3	3	3	2	3	2
CO5	3	3	3	3	3	2

Semester: I						
DIGITAL SATELLITE IMAGE PROCESSING LABORATORY						
Course Code	:	1MCVL107H		**Credits**	:	1
Teaching Hours/Week (L: T:P)	:	28(0: 0: 2)		**CIE**	:	50 Marks
Total Hours of Pedagogy L: T:P: TW&SL	:	30(0: 0:28:2)		**SEE**	:	50 Marks
Course Type	:	PCCL		**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	Remote Sensing, GIS, Engineering Surveying
Knowledge on Fundamental Concepts	Satellite images, image bands, coordinates, GIS and image interpretation
Knowledge on Connected Tools (If any)	ERDAS Imagine, ENVI, QGIS and image processing tools

Course Learning Objectives: This course will enable the students to	
CLO1	Describe digital satellite image processing concepts and software tools.
CLO2	Apply image enhancement, filtering and band combination techniques.
CLO3	Perform geo-referencing, image correction and image classification.
CLO4	Prepare and interpret classified and thematic satellite image outputs.
CLO5	Develop digital remote sensing outputs for real-world applications.

	PART- A FIXED EXPERIMENTS	**LI-28 Hrs**
1	Introduction to satellite image processing software interface, image import, display, band selection, and visualization basics.	
2	Image enhancement using contrast stretching, histogram equalization, brightness adjustment, and spatial filtering.	
3	False colour composite preparation and interpretation using standard band combinations.	
4	Geo-referencing and image registration of a satellite image using ground control points.	
5	Image correction and sub setting using resampling, clipping, and coordinate system assignment.	
6	Supervised classification of a satellite image for land use/land cover mapping.	
7	Unsupervised classification and accuracy assessment using class signature analysis.	
8	Change detection or thematic mapping of an area using multi-date satellite images.	
	PART-B OPEN ENDED EXPERIMENTS	
1	Develop a satellite image processing workflow for land use and land cover analysis of a given region.	
2	Modify a satellite image enhancement approach to improve feature visibility in a chosen area.	
3	Prepare a geo-referenced image product for urban, agricultural, or water resource interpretation.	
4	Design a classification scheme for extracting terrain, vegetation, or built-up features from satellite data.	
5	Create a change detection study using two satellite images acquired at different time periods.	

6	Generate a complete digital remote sensing output set with preprocessing, enhancement,

Course Outcomes: After completing the course, the students will be able to	
CO1	Operate digital image processing tools to import, visualize and preprocess satellite images.
CO2	Apply enhancement, filtering and band combination techniques to analyze satellite images.
CO3	Perform geo-referencing, image correction and thematic analysis of satellite images.
CO4	Generate classified, annotated and interpreted satellite image outputs for reporting.
CO5	Interpret real-world remote sensing problems using digital image processing techniques.

Text Books	
1	Thomas M. Lillesand, Ralph W. Kiefer and Jonathan W. Chipman, Remote Sensing and Image Interpretation**,** Wiley**,** 7th Edition, 2015, ISBN: 978-1-118-34328-9.
2	John A. Richards and Xiuping Jia, Remote Sensing Digital Image Analysis: An Introduction, Springer, 5th Edition, 2013, ISBN: 978-3-642-30062-2**.**
3	Hexagon Geospatial, ERDAS IMAGINE User Guide, Hexagon Geospatial,
Reference Books/Manuals	
1	NRSC/ISRO remote sensing data interpretation and image processing guides.
2	Relevant standards and technical notes on satellite data products and map preparation.
3	Standard remote sensing laboratory manuals.

Web links and Video Lectures (e–Resources)	
1	NPTEL: Remote Sensing and GIS.
2	NPTEL / IIT courses on digital image processing and remote sensing applications.
3	Online resources on satellite image enhancement, classification, and change detection

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3				3	
CO2	3	3			3	
CO3	3	3		2	3	
CO4	3	3	2	2	3	
CO5	3	3	3	3	3	2

Semester: I						
Non-Destructive Testing Laboratory						
Course Code	**:**	1MCVL107I		**Credits**	**:**	1
Teaching Hours/Week (L: T:P)	**:**	28(0: 0: 2)		**CIE**	**:**	50 Marks
Total Hours of Pedagogy L:T:P: TW&SL	**:**	30(0: 0:28:2)		**SEE**	**:**	50 Marks
Course Type	**:**	PCCL		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Concrete Technology; Strength of Materials; Structural Analysis
Knowledge on Fundamental Concepts	Basic knowledge of concrete, strength, durability, reinforcement, cover and corrosion.
Knowledge on Connected Tools (If any)	Basic knowledge of Rebound Hammer, UPV Tester, Half-Cell Potentiometer, Cover Meter, Core Cutting and Liquid Penetrant Testing Kit.

Course Learning Objectives: This course will enable the students to	
CLO1	Explain the basic principles and applications of NDT methods for concrete structures.
CLO2	Perform rebound hammer and UPV tests to assess concrete strength and quality
CLO3	Determine reinforcement location, concrete cover, carbonation depth and corrosion condition.
CLO4	Conduct core extraction and chemical tests to assess the condition and durability of concrete.
CLO5	Interpret test results to identify defects and assess the condition of concrete structures

	PART- A FIXED EXPERIMENTS	**LI-28 Hrs**
1	Determination of Concrete Compressive Strength Using Rebound Hammer Test	
2	Assessment of Concrete Quality and Uniformity Using Rebound Hammer	
3	Determination of Ultrasonic Pulse Velocity by Direct Transmission Method	
4	Assessment of Concrete Quality and Detection of Internal Cracks/Voids Using UPV Test	
5	Determination of Carbonation Depth of Concrete Using Phenolphthalein Indicator	
6	Extraction of Concrete Core and Determination of In-Situ Compressive Strength	
7	Determination of Reinforcement Bar Diameter, Spacing and Concrete Cover Using Cover Meter	
8	Chemical Analysis of Concrete for Chloride and Sulphate Ingress	
	PART-B OPEN ENDED EXPERIMENTS	
1	Comparison of Rebound Hammer Readings at Different Locations of Concrete	
2	Comparison of UPV Values for Different Concrete Specimens	
3	Study of Effect of Concrete Surface Condition on Rebound Hammer Readings	
4	Study of Effect of Moisture Condition on UPV of Concrete	
5	Estimation of Concrete Strength Using Combined Rebound Hammer and UPV Tests	
6	Mapping of Concrete Cover and Reinforcement Spacing Using Cover Meter	

Course Outcomes: After completing the course, the students will be able to	
CO1	Identify appropriate non-destructive testing methods and equipment for concrete and reinforced concrete structures.
CO2	Perform rebound hammer and ultrasonic pulse velocity tests for assessing concrete strength, quality and uniformity.
CO3	Determine reinforcement location, spacing, diameter, concrete cover, carbonation depth and corrosion condition using suitable testing techniques.
CO4	Evaluate the in-situ condition and durability of concrete using core extraction and

	chemical analysis tests.
CO5	Develop suitable test reports based on experimental observations and test results for concrete defects and condition assessment.

Text Books	
1	J. H. Bungey, S. G. Millard and M. G. Grantham, Testing of Concrete in Structures, 4th Edition, Taylor & Francis, 2006.
2	V. M. Malhotra and Nicholas J. Carino, Handbook on Nondestructive Testing of Concrete, 2nd Edition, CRC Press, 2004.
3	A. M. Neville, Properties of Concrete, 5th Edition, Pearson, 2011.

Reference Books	
1	J. H. Bungey and S. G. Millard, Testing of Concrete in Structures, 3rd Edition, Blackie Academic & Professional, 1996.
2	V. M. Malhotra and N. J. Carino, Handbook on Nondestructive Testing of Concrete, CRC Press.
3	C. Maierhofer, H.-W. Reinhardt and G. Dobmann (Eds.), Non-destructive Evaluation of Reinforced Concrete Structures, Woodhead Publishing, 2010.

Code / Standard	
1	IS 13311 (Part 1):1992, Methods of Non-Destructive Testing of Concrete – Part 1: Ultrasonic Pulse Velocity, Bureau of Indian Standards.
2	IS 13311 (Part 2):1992, Methods of Non-Destructive Testing of Concrete – Part 2: Rebound Hammer, Bureau of Indian Standards.
3	ASTM C876, Standard Test Method for Corrosion Potentials of Uncoated Reinforcing Steel in Concrete.

Web links and Video Lectures (e–Resources)	
1	Bureau of Indian Standards – Standards Portal: https://standards.bis.gov.in/
2	American Concrete Institute – Committee 228, Nondestructive Testing of Concrete: https://www.concrete.org/getinvolved/committees/directoryofcommittees/acommitteehome/committee_code/c0022800.aspx
3	American Concrete Institute – Nondestructive Testing Resources: https://www.concrete.org/topicsinconcrete/topicdetail?search=nondestructive+testing
4	CSIR–Structural Engineering Research Centre – Advanced Concrete Testing & Evaluation Laboratory: https://serc.res.in/advanced-concrete-testing-evaluation-laboratory-actel

CO – PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2		1	2	
CO2	3	3		2	3	
CO3	3	3		3	3	1
CO4	3	3		3	3	1
CO5	2	3	1	3	3	2

Institute Vision

Preparing Competent Engineering and Management Professionals to Serve the Society

Institute Mission

- Providing Students with a Sound Knowledge in Fundamentals of their branch of Study.
- Promoting Excellence in Teaching, Training, Research and Consultancy.
- Exposing Students to Emerging Frontiers in various domains enabling Continuous Learning.
- Developing Entrepreneurial acumen to venture into Innovative areas.
- Imparting Value based Professional Education with a sense of Social Responsibility.

Department Vision

Building Competent Civil Engineers with a Societal Perspective

Department Mission

- Providing Conducive Learning Environment focusing on Planning, Analysis, Design and Detailing of Sustainable Infrastructure
- Imparting Training, Research and Consultancy in Collaboration with Research Institutes and Industries.
- Equipping Students with Employability Skills through Internships, Industrial Interactions and Field Visits
- Exploring Comprehensive Environmental Aware Solutions for Various Fields of Civil Engineering with Multidisciplinary Approach
- Imbibing Lifelong Learning, Professionalism and Ethics among Civil Engineering Students

SJC INSTITUTE OF TECHNOLOGY

An Autonomous Institution under VTU from 2024-25

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