Shri Vile Parle Kelavani Mandal's

NMIMS Global University, Dhule

School of Technology, Management & Engineering
Survey No. 499, Plot No. 02, Behind Gurudwara,
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Curriculum Structure and Syllabus Of
First Year M. Tech. (Civil Engineering)
(Regulation 2025)



Effective from Academic Year 2025-26

Vision

"SVKM NMIMS Global University aspires to be a world-renowned institution of higher learning, dedicated to fostering excellence in education, research and innovation with social responsibility"

Mission

1. To foster a dynamic and inclusive learning environment that nurtures the educational and research aspirations of students from diverse backgrounds.
2. To deliver state-of-the-art pedagogy, emphasizing interdisciplinary collaboration and innovation.
3. To uphold the values of ethics and community engagement to cultivate global citizens and leaders who actively contribute to the advancement of society and the world.

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CURRICULUM FRAMEWORK

LIST OF ABBREVIATIONS

Sr. No.	Abbreviation	Meaning
1	T	Technology
2	25	Scheme
3	B	Civil
4	501–507	Course Series Sem-I
5	CM	Computational Methods for Civil Engineering
6	SC	Smart Construction Management
7	GE	Advanced Geotechnical Engineering
8	IT	Intelligent Transport Systems
9	FEM	Finite Element Methods
10	SCT	Sustainable Concrete Technology
11	SS	Smart Structures and Dynamics Laboratory
12	GT	Geotechnical Testing Lab
13	RA	Research & Analytics
14	ET	Emerging Trends in Civil Engineering
15	AM	AI & Machine Learning in Civil Engineering
16	AI	Artificial Intelligence Lab
17	WR	Water Resources & Climate Resilience
18	HW	Hydrology & Water Quality Lab
19	SD	Structural Dynamics
20	AS	Advanced Structural Design
21	UF	Urban Flood Management & Drainage Systems
22	HS	Hydraulic Structures & Coastal Engineering
23	EI	Environmental Impact Assessment
24	SI	Sustainable Infrastructure & Management System
25	PP	Prototyping and Product Development

SEMESTER-WISE COURSE DISTRIBUTION

Sr. No.	Type of Course	Course Distribution: Semester Wise			Credit Distribution: Semester Wise		
		No. of Courses / Semester			No. of Credits / Semester		
		I	II	Total	I	II	Total
1.	Programme Core Course (PCC)	6	4	**10**	14	8	**22**
2.	Programme Elective Course (PEC)	2	6	**8**	3	9	**12**
3.	Vocational and Skill Enhancement Course (VSEC)	1	1	**2**	2	2	**4**
4.	Experiential Learning Courses (ELC)	1	1	**2**	1	1	**2**
Total		**10**	**12**	**22**	**20**	**20**	**40**

Sr. No.	Type of Course	Course Distribution: Semester Wise			Credit Distribution: Semester Wise		
		No. of Courses / Semester			No. of Credits / Semester		
		III	IV	Total	III	IV	Total
1.	Experiential Learning Courses (ELC)	3	2	**5**	20	20	**40**
Total		**3**	**2**	**5**	**20**	**20**	**40**

Curriculum Structure

M. Tech.

Civil Engineering

CURRICULUM STRUCTURE

First Year M. Tech. (Civil Engineering) Semester – I

First Year M. Tech. (Regulations 2025) (With effect from Academic Year 2025-26)													
Semester I (Credits = 20)													
Sr. No.	**Course Code**	**Course Name**	**Teaching & Credit Scheme (Hours/ Week)**				**Evaluation Scheme and Marks**						
							Continuous Assessment			**End Semester Assessment**			
			L	**P**	**T**	**Credits**	**Term Test (TT)**	**Term Work (TW)**	**Internal Assessment (A)**	**Theory**	**Oral & Practical**	**ESE Total (B)**	**Total (A+B)**
1	T25BCM501	Computational Methods for Civil Engineering	3	0	0	3	40	0	40	60	0	60	100
2	T25BSC502	Smart Construction Management	3	0	0	3	40	0	40	60	0	60	100
3	T25BSS502L	Smart Structures and Dynamics Laboratory	0	2	0	1	0	25	25	0	25	25	50
4	T25BGE503	Advanced Geotechnical Engineering	3	0	0	3	40	0	40	60	0	60	100
5	T25BGT503L	Geotechnical Testing Lab	0	2	0	1	0	25	25	0	25	25	50
6	T25BIT504	Intelligent Transport Systems	3	0	0	3	40	0	40	60	0	60	100
7	T25BFEM505 / T25BSCT505	Finite Element Methods / Sustainable Concrete Technology	3	0	0	3	40	0	40	60	0	60	100
8	T25BRA506	Research & Analytics	0	2	0	2	0	50	50	0	50	50	100
9	T25BET507	Emerging Trends in Civil Engineering	0	2	0	1	0	50	50	0	0	0	50
Total			**15**	**8**	**0**	**20**	**200**	**150**	**350**	**300**	**100**	**400**	**750**

CURRICULUM STRUCTURE

First Year M. Tech. (Civil Engineering) Semester – II

First Year M. Tech. (Regulations 2025) (With effect from Academic Year 2025-26) Semester II (Credits = 20)														
Sr. No.	**Course Code**	**Course Name**	**Teaching & Credit Scheme (Hours/ Week)**				**Evaluation Scheme and Marks**							
							Continuous Assessment			**End Semester Assessment**			**Total (A+B)**
			L	**P**	**T**	**Credits**	**Term Test (TT)**	**Term Work (TW)**	**Internal Assessment (A)**	**Theory**	**Oral & Practical**	**ESE Total (B)**	
1	T25BAM551	AI & Machine Learning in Civil Engineering	3	0	0	3	40	0	40	60	0	60	100
	T25BAI551L	Artificial Intelligence Lab	0	2	0	1	0	25	25	0	25	25	50
2	T25BWR552	Water Resources & Climate Resilience	3	0	0	3	40	0	40	60	0	60	100
	T25BHW552L	Hydrology & Water Quality Lab	0	2	0	1	0	25	25	0	25	25	50
3	T25BSD553	Structural Dynamics	3	0	0	3	40	0	40	60	0	60	100
	T25BAS553	Advanced Structural Design											
4	T25BUF554	Urban Flood Management & Drainage Systems	3	0	0	3	40	0	40	60	0	60	100
	T25BHS554	Hydraulic Structures & Coastal Engineering											
5	T25BEI555	Environmental Impact Assessment	3	0	0	3	40	0	40	60	0	60	100
		Sustainable Infrastructure & Management System											
6	T25BPP556	Prototyping and Product Development	0	2	0	2	0	50	50	0	50	50	100
7	T25BFT557	FutureTech in Civil Engineering: AI, IoT & Digital Solutions	0	2	0	1	0	50	50	0	0	0	50
Total			**15**	**8**	**0**	**20**	**200**	**150**	**350**	**300**	**100**	**400**	**750**

CURRICULUM STRUCTURE

Second Year M. Tech. (Civil Engineering) Semester – III

Second Year M. Tech. (Regulations 2025) **(With effect from Academic Year 2025-26)**													
Semester III (Credits = 20)													
Sr. No.	**Course Code**	**Course Name**	**Teaching & Credit Scheme (Hours/ Week)**				**Evaluation Scheme and Marks**						
							Continuous Assessment			**End Semester Assessment**			**Total (A+B)**
			L	**P**	**T**	**Credits**	**Term Test (TT)**	**Term Work (TW)**	**Internal Assessment (A)**	**Theory**	**Oral & Practical**	**ESE Total (B)**	
1	T25BNCE601	Next-Gen Civil Engineering: AI, Big Data & Digital Transformation (NGCE-ABDT)	0	4	0	2	25	25	50	0	50	50	100
2	T25BRP1602	Research Paper Publication -I	0	4	0	2	25	25	50	25	25	50	100
3	T25BDP1603	Dissertation Phase-I	0	32	0	16	100	100	200	0	300	300	500
Total			**0**	**40**	**0**	**20**	**150**	**150**	**300**	**25**	**350**	**400**	**700**

CURRICULUM STRUCTURE

Second Year M. Tech. (Civil Engineering) Semester – IV

Second Year M. Tech. (Regulations 2025) **(With effect from Academic Year 2025-26)**													
Semester IV (Credits = 20)													
Sr. No.	**Course Code**	**Course Name**	**Teaching & Credit Scheme (Hours/ Week)**				**Evaluation Scheme and Marks**						
							Continuous Assessment			**End Semester Assessment**			**Total (A+B)**
			L	**P**	**T**	**Credits**	**Term Test (TT)**	**Term Work (TW)**	**Internal Assessment (A)**	**Theory**	**Oral & Practical**	**ESE Total (B)**	
1	T25BRP2651	Research Paper Publication -II	0	4	0	2	25	25	50	50	0	50	**100**
2	T25BDP2652	Dissertation Phase-II	0	36	0	18	150	150	300	0	300	300	**600**
Total			**0**	**40**	**0**	**20**	**175**	**175**	**350**	**50**	**300**	**350**	**700**

L-Lecture, **P**-Practical, **T**-Tutorial, **TT**–Term Test, **TW**-Term Work, **Cred**- Credits, **ESE**- End Semester Examination

Internal Assessment: Assignment/Group Discussion/Course Project/Quiz/Presentation/Any Other etc.

Program:	First Year M. Tech. (Civil Engineering)						Semester: I
Course:	Computational Methods for Civil Engineering						Code: T25BCM501
Credit	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	Continuous Assessment			Total
				TT1	TT2	Internal Assessment	
03	03	-	-	20	20	40	100

Course Objectives:

- To develop the ability to formulate, model, and solve civil engineering problems using computational approaches.
- To develop problem-solving skills for applying numerical and computational methods.
- To provide an in-depth understanding of numerical stability, convergence, and algorithmic complexity for engineering applications.

Course Outcomes: By the end of this course, students will be able:

1. To apply numerical methods for solving civil engineering problems
2. To analyze numerical techniques like differential equations and finite difference/finite element methods for structural, geotechnical, transportation and hydrological problems.
3. To analyze optimization and machine learning techniques for civil engineering applications such as mix design, pavement maintenance, and predictive modeling.

Detailed Syllabus

Unit	Description	Duration (Hrs.)	BL	CO
I	Fundamentals of Numerical Computation and Algorithms- Types of errors, numerical stability, convergence, Root finding: Bisection, Newton-Raphson methods, Solving linear systems: Gauss elimination, LU decomposition, Iterative solvers (Gauss-Seidel), Applications in beam and frame analysis	8	**L5**	**CO1**
II	**Interpolation, Curve Fitting & Numerical Integration -** **P**olynomial interpolation: Newton, Lagrange, Spline interpolation for geotechnical and traffic data, Numerical integration, Trapezoidal rule, Simpson's rule, Applications: Soil settlement prediction, structural loading curves	8	**L3**	**CO2**
III	**Differential Equations and Finite Difference Methods- Ordinary** Differential Equations: Euler, Runge-Kutta methods, Partial Differential Equations: Laplace, heat and wave equations using FDM, Stability, accuracy and boundary	8	**L4**	**CO3**

	conditions, Applications: Groundwater flow, unsteady pipe flow			
IV	**Finite Element Method for Civil Applications-** 1D Finite Element formulation: bar, truss, beam elements, Assembly of global matrices and boundary conditions, Introduction to 2D FEM concepts (plane stress/strain), Applications: Structural analysis, slab behavior, retaining walls,	8	**L3**	**CO3**
V	**Optimization and Emerging Computational Techniques-** Optimization: Linear, nonlinear programming, Genetic Algorithms, Introduction to ML models (Linear regression, Decision Trees) for civil data, Concrete mix prediction, pavement maintenance scheduling using ML	7	**L3**	**CO3**
Total		**39**		

Text Books

1. S.S. Sastry – Introductory Methods of Numerical Analysis
2. Reddy, J.N. – An Introduction to the Finite Element Method
3. Chapra & Canale – Numerical Methods for Engineers
4. Kiusalaas, J. – Numerical Methods in Engineering with Python

Relevant ASCE and Elsevier journal articles on computational civil engineering

Reference Books:

1. S.S. Sastry – Introductory Methods of Numerical Analysis
2. Reddy, J.N. – An Introduction to the Finite Element Method
3. Chapra & Canale – Numerical Methods for Engineers
4. Kiusalaas, J. – Numerical Methods in Engineering with Python

Relevant ASCE and Elsevier journal articles on computational civil engineering

Digital Resources:

1. https://onlinecourses.nptel.ac.in/noc25_ce76/preview

Prepared by **Verified by** **M. Tech. Coordinator** **HOD** **Dean**

Program:	First Year M. Tech. (Civil Engineering)						Semester: I	
Course:	Smart Construction Management						Code: T25BSC502	
Credit	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks				
	Lecture	Practical	Tutorial	Continuous Assessment			ESE	Total
				TT 1	TT 2	Internal Assessment		
03	03	-	-	20	20	40	60	100

Course Objectives:

- COBJ1: Provide in-depth understanding of advanced construction management principles, focusing on digitalization and smart technologies.
- COBJ2: Introduce Industry 4.0 tools and technologies for planning, scheduling, cost control, and quality management in construction projects.
- COBJ3: Develop skills for implementing Building Information Modelling (BIM), IoT, AI/ML, Digital Twins, and Automation in construction projects.
- COBJ4: Equip students with decision-making techniques using data analytics and simulation for optimizing construction processes.
- COBJ5: Enable learners to analyze real-world case studies, evaluate risks, and implement sustainable and smart project management strategies

Course Outcomes:

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

CO1: enable students to understand the fundamental principles of smart construction man-agement, Industry 4.0 concepts, lean construction, KPIs, and sustainability frameworks.

CO2: To familiarize students with digital tools and technologies such as BIM, IoT, robotics, and digital twins, and their application in construction project planning and monitoring.

CO3: To equip students with advanced project planning, scheduling, risk management, and AI/ML-based predictive control techniques for improved project performance.

CO4: To develop students' ability to apply big data analytics, cloud platforms, dashboards, and cybersecurity measures for data-driven decision-making in construction projects.

CO5: To empower students to analyze real-world case studies, evaluate global best practices, and propose smart and sustainable construction management strategies for future pro-jects.

Detailed Syllabus

Unit	Description	Duration (Hrs.)	CO	BL
I	**Fundamentals of Smart Construction Management** Introduction to Construction Management: Traditional vs Smart Practices, Industry 4.0 and Construction 4.0 concepts, Lean Construction principles, Key Performance Indicators (KPIs) for Smart Construction Sustainable Development Goals (SDGs) and Green Project Management	8	CO1	L4
II	**Digital Technologies in Construction** Building Information Modelling (BIM): Level 0-3, Common Data Environment (CDE) Integration of BIM with Scheduling (4D) and Cost Estimation (5D) Internet of Things (IoT) in Construction: Sensors, Wearables, Real-time Monitoring	8	CO2	L5

	Construction Robotics, Drones, and Automation, Introduction to Digital Twin Technology			
III	**Advanced Planning and Control Techniques** AI/ML applications in Construction Management Predictive Maintenance and Smart Equipment Management Decision Support Systems, Simulation Techniques (Monte Carlo, Discrete Event Simulation) Advanced Scheduling: Critical Chain Project Management (CCPM) Risk Management Frameworks & Contingency Planning	8	CO3	L6
IV	**Data-Driven Construction Management** Big Data Analytics in Construction Projects Cloud Computing for Collaboration and Information Sharing Dashboards and Visualization Tools (Power BI/Tableau) Cybersecurity in Construction Projects Case Studies: Data-Driven Decision-Making in Mega Projects	8	CO4	L5
V	**Implementation and Case Studies** Smart Contracts and Blockchain for Construction Projects Life Cycle Assessment (LCA) for Sustainable Construction Smart City and Infrastructure Case Studies (Metro, Highways, Airports) Lessons Learned from Global Best Practices Future Trends and Research Opportunities	7	CO5	L6
Total		**39**		

Text Books

- Prasanna Chandra – Projects: Planning, Analysis, Selection, Financing, Implementation, and Review – Tata McGraw Hill.
- Charles Hendrickson – Project Management for Construction: Fundamental Concepts for Owners, Engineers, Architects and Builders – Prentice Hall.

Eastman, C., Teicholz, P., Sacks, R., & Liston, K. – BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers – Wiley.

Reference Books:

- Shashi K. Goyal & Niraj Kumar – Construction Management and Planning – Laxmi Publications.
- Chitkara, K. K. – Construction Project Management: Planning, Scheduling, and Controlling – Tata McGraw Hill.
- Molenaar, K., Gransberg, D. – Alternative Project Delivery, Procurement, and Contracting Methods – ASCE Press.
- K. S. Jha – Construction Project Management – Pearson Education.

Selected research papers from journals like Automation in Construction, Journal of Construction

Engineering and Management (ASCE), and Engineering, Construction and Architectural Management.
Digital Resources: -----

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Program:	**First Year M. Tech. (Civil Engineering)**			**Semester: I**		
Course:	**Smart Structures and Dynamics Laboratory**			**Code: T25BSS502L**		
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**		
	Lecture	**Practical**	**Tutorial**	**TW**	**PR & OR**	**Total**
01	**-**	**02**	**-**	**25**	**25**	**50**

Course Objectives:

This course aims at enabling students:

- To develop practical skills in using FEM-based simulation tools for the analysis of various structural elements.
- To enable students to model, analyze, and interpret the behavior of structures under static and dynamic loading using commercial software.
- To bridge the gap between theoretical concepts of FEM and real-world structural engineering applications through hands-on simulations..

Course Outcomes:

After learning the course, the students will be able to:

CO 1: Apply finite element principles to simulate and analyze the behavior of structural components like beams, frames, and plates.

CO 2: Use FEM software tools (e.g., ANSYS, ABAQUS, STAAD.Pro, ETABS) to perform structural analysis under various loading and boundary conditions.

CO 3: Interpret simulation results critically and validate FEM solutions with theoretical or analytical benchmarks.

Guidelines for Students:

The laboratory practical is to be submitted by students in the form of a journal.

1. Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each practical.
2. Each assignment write-up should have Title, Objectives, out comes, Theory- Concept in brief, and Conclusion.

Guidelines for Laboratory/Term Work Assessment:

1. Continuous assessment of laboratory work is based on overall performance and Laboratory practical performance of student.
2. Each Laboratory practical assessment will assign grade/marks based on parameters with appropriate weightage.
3. Suggested parameters for overall assessment as well as each Laboratory practical assessment include- timely completion, performance, innovation, efficient codes, punctuality, and neatness**.**

Guidelines for Laboratory Conduction

1. Understand the Theory Behind the Experiment.
2. Ensure Proper Setup and Calibration of Equipment.
3. Follow Safety Protocols and Best Practices
4. Collect data systematically, ensuring accuracy in measurements.

Record all observations and results promptly and clearly in the lab notebook.

Detailed Syllabus

Suggested List of Experiments

(Minimum 13 experiments are to be performed based on contents from syllabus)

Experiment No.	Experiment Title	BL	CO
1.	Introduction to FEM Software Tools	L2 L3 L4 L5	CO1,2,3,4,5
2.	1D Structural Analysis: Truss and Beam Elements		
3.	2D Plane Stress and Plane Strain Problems.		
4.	Analysis of Axisymmetric Elements		
5.	Static Analysis of a 3D Frame		
6.	Modal Analysis of Beam and Frame Structures		
7.	Analysis of Plate Bending using Shell Elements		
8.	Thermal Stress Analysis		
9.	Nonlinear Static Analysis		
10.	Introduction to Meshing and Convergence Study		
11.	Dynamic Response Analysis under Time-Varying Load		
12.	Design and Analysis of RCC Frame using STAAD.Pro/ETABS		
13.	Comparison of FEM Results with Theoretical/Analytical Results		

References:

Recommended Books

- Structural Analysis – Author: C. S. Reddy
- Finite Element Method – Author: S. S. Bhavikatti
- Finite Element Analysis – Author: P. Seshu
- Concepts and Applications of Finite Element Analysis – Authors: Robert D. Cook, David S. Malkus, Michael E. Plesha
- The Finite Element Method – Authors: O. C. Zienkiewicz, R. L. Taylor
- Theory of Elasticity – Authors: S. P. Timoshenko, J. N. Goodier

Softwares-

- ANSYS Workbench
- STAAD.Pro
- ETABS
- SAP2000

Indian Codes (Must include)

- IS 456
- IS 800

	• IS 1893 • IS 875 **Online Learning** • NPTEL – FEM & structural analysis courses • IIT Bombay – Simulation lectures IIT Madras – Advanced FEM resources

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Program:	**First Year M. Tech. (Civil Engineering)**						**Semester: I**	
Course:	**Advanced Geotechnical Engineering**						**Code: T25BGE503**	
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**				
	Lecture	**Practical**	**Tutorial**	**Continuous Assessment**			**ESE**	**Total**
				TT1	**TT2**	**Internal Assessment**		
03	**03**	**-**	**-**	**20**	**20**	**40**	**60**	**100**

Course Objectives:

- To develop understanding of soil properties and fundamental geotechnical principles.
- To equip students with skills in soil exploration and field testing techniques.
- To introduce foundation instrumentation and interpretation of monitoring data.
- To enable analysis and design of shallow foundations under various conditions.
- To provide knowledge for analysis and design of deep foundations systems.

Course Outcomes:

After completing the course, students will be able to:

1. Understand soil properties and basic geotechnical principles for foundation engineering.
2. Apply knowledge of soil exploration techniques and field testing methods for site characterization.
3. Select appropriate foundation instrumentation and interpret monitoring data.
4. Analyze and design shallow foundations considering bearing capacity, settlement, and load conditions.
5. Analyze and design deep foundations (piles, wells, caissons) under various loading and soil conditions.

Detailed Syllabus

Unit	**Description**	**Duration (Hrs.)**	**BL**	**CO**
I	**Basics of Geotechnical Engineering** Introduction to Geotechnical Engineering, Soil formation, types of soils, index properties of soils, Soil classification systems (IS, USCS), Permeability,	8	L4	CO1

	Seepage analysis, Flow nets, Compaction of soils – laboratory and field methods, Consolidation of soils – settlement and rate of consolidation, Shear strength of soils – Mohr-Coulomb theory, shear strength tests			
II	**Geotechnical Exploration and Field Testing** Importance and planning of subsoil exploration, Boring methods: auger boring, wash boring, rotary drilling, Sampling techniques: disturbed and undisturbed samples, In-situ penetration tests: Standard Penetration Test (SPT), Cone Penetration Test (CPT), Plate load test, field vane shear test, pressure meter test, large box shear test, Geophysical methods: seismic and electrical resistivity, Foundation instrumentation: settlement gauges, displacement gauges, piezometers, strain gauges	8	L5	CO2
III	**Shallow Foundations** Bearing capacity concepts – Terzaghi's theory, general shear and local shear failure, Bearing capacity from IS code provisions, Settlement analysis: immediate, consolidation and secondary settlement, Design of isolated and combined footings under vertical, horizontal and moment loading, Design of rafts in sandy and clayey soils, Foundations on rocky strata	8	L6	CO3
IV	**Deep Foundations** Introduction to pile foundations: necessity, classification, installation, Load carrying capacity of single piles in sandy and clayey soils, Pile load tests – static and dynamic methods, Negative skin friction and uplift capacity of piles, Settlement analysis of pile foundations, Group piles – efficiency, settlement, and design considerations, Piles subjected to lateral and moment loading	8	L6	CO4
V	**Advanced Foundation Topics & Case Studies** Well foundations and caissons – components, design principles, construction, Foundations under uplift and overturning loads, Ground improvement techniques for foundations (stone columns, sand drains, and soil stabilization), Case studies of foundation failures and remedial measures, Recent advances: use of geosynthetics, instrumentation in modern geotechnics, and smart monitoring of foundations.	7	L6	CO5
Total		**39**		

Text Books

- Narasinga Rao, B. N. D. – Soil Mechanics and Foundation Engineering (Wiley India).
- (Widely used textbook covering fundamentals with many numerical problems for exams like GATE/IES)
- K. R. Arora – Soil Mechanics and Foundation Engineering
- V. N. S. Murthy – Soil Mechanics and Foundation Engineering

- N. V. Nayak – Foundation Design Manual
- Jitendra Chaudhary – Geotechnical Engineering & Foundation Design (S.K. Kataria & Sons)

(Covers soil properties, exploration, and foundation design topics in detail)

Reference Books:

1.Foundation Engineering Hand book, Winterkorn& Fang

2. Analysis & Design of Pile Foundation, Polous& Davis

3. Foundation Design Manual, N.V. Nayak

4. Foundation Analysis and Design- Joseph E. Bowels, TATA Mc-Grawhill

5. Design Aids in Soil Mechanics and Foundation Engineerimg, Shenbage R Kaniraj, TATA Mc-Grawhill

6. Design of Foundation Systems, Nainan P Kurian, Narosa publication house

7. Foundation Design & Construction, M.J.Tomlinson, ELBS publication

8. Foundation Engineering Hand book, Hsai-Yang-Fang, Chapman & hall, New York.

9. Foundaton Engineering-Nitin Som

10. Advanced Foundation Engineering-B.M.Das

11. Poulos, H. G. (2016). Tall building foundations: design methods and applications. Innovative Infrastructure Solutions, 1(1), 10..

Digital Resources:

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Program:	**First Year M. Tech. (Civil Engineering)**			**Semester: I**		
Course:	**Geotechnical Testing Lab**			**Code: T25BGT503L**		
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**		
	Lecture	**Practical**	**Tutorial**	**TW**	**PR & OR**	**Total**
01	**-**	**02**	**-**	**25**	**25**	**50**

Course Objectives:

This course aims at enabling students:

- To develop skills in performing and interpreting laboratory tests such as hydrometer and consolidation tests.

- To enable analysis and interpretation of advanced soil tests including swelling pressure and triaxial tests with pore pressure measurement.
- To provide exposure to computer software tools for geotechnical analysis and design.

Course Outcomes:

After learning the course, the students will be able to:

1. Perform and interpret the laboratory experiments such as Hydrometer Test, Consolidation Test.
2. Perform and interpret the laboratory experiments such as Swelling Pressure Test, Tri-axial Test with Measurement of Pore Pressure.
3. Use a suitable computer software for analysis and design of geotechnical problems

Guidelines for Students:

The laboratory practical is to be submitted by students in the form of a journal.

- Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each practical.
- Each assignment write-up should have Title, Objectives, out comes, Theory- Concept in brief, and Conclusion.

Guidelines for Laboratory/Term Work Assessment:

- Continuous assessment of laboratory work is based on overall performance and Laboratory practical performance of student.
- Each Laboratory practical assessment will assign grade/marks based on parameters with appropriate weightage.
- Suggested parameters for overall assessment as well as each Laboratory practical assessment include- timely completion, performance, innovation, efficient codes, punctuality, and neatness**.**

Guidelines for Laboratory Conduction

- Understand the Theory Behind the Experiment.
- Ensure Proper Setup and Calibration of Equipment.
- Follow Safety Protocols and Best Practices
- Collect data systematically, ensuring accuracy in measurements.
- Record all observations and results promptly and clearly in the lab notebook.

Detailed Syllabus

Suggested List of Experiments

(Minimum 3 experiments and 2 assignments are to be performed based on contents from syllabus)

Experiment No.	Experiment Title (Any Three)	BL	CO
1.	Hydrometer Analysis	5	1
2.	Consolidation Test	5	1
3.	Swelling Pressure Test	5	1
4.	Standard Penetration Test	5	2
5.	Plate Load Test	5	2
Assignment No.	**Assignments (Any Two)**		
1.	Use of software for analysis and design of substructure, stability of slopes, Seepage Analysis, retaining structure.	6	3

References:

Recommended Books

SP 36 (Part I) 1987 Compendium of Indian Standards on Soil Engineering: Part I Laboratory testing of soils for civil engineering purposes

Prepared by **Verified by** **M. Tech. Coordinator** **HOD** **Dean**

Program:	**First Year M. Tech. (Civil Engineering)**							**Semester: I**
Course:	**Intelligent Transport Systems**							**Code: T25BIT504**
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**				
	Lecture	**Practical**	**Tutorial**	**Continuous Assessment**			**ESE**	**Total**
				TT 1	**TT 2**	**Internal Assessment**		
03	**03**	**-**	**-**	**20**	**20**	**40**	**60**	**100**

Course Objectives:

- Understand advanced ITS architectures, data protocols, and global standards
- Explore the use of modern technologies like edge computing, AI, and IoT in transport
- Apply simulation and modelling to real-time traffic and mobility management
- Discuss the ethical, legal, and policy dimensions of ITS deployment
- Design innovative and locally adaptable ITS solutions for both cities and rural areas

Course Outcomes:

After completing the course, students will be able to:

CO1: Design smart transportation systems using cutting-edge communication and sensing technologies

CO2: Use data-driven approaches to solve real-world transport problems

CO3: Analyse international ITS deployments and derive lessons for Indian conditions

CO4: Integrate ITS strategies into smart city frameworks and infrastructure projects

CO5: Evaluate legal, cybersecurity, and ethical concerns related to ITS technologies

Detailed Syllabus

Unit	**Description**	**Duration (Hrs.)**	**BL**	**CO**
I	**Intelligent Transportation System Architecture and Standards** Historical development and evolution of intelligent transportation systems, Frameworks and architecture models used globally, International communication standards for transportation data exchange, System compatibility and standard data formats for real-time integration	8	L4	CO1
II	**Sensors, Internet of Things, and Edge Computing in Intelligent Transportation** Application of advanced sensors such as laser-	8	L5	CO2

	based detectors, radio detection, and image-based recognition systems, Integration of Internet of Things devices in transportation networks, Edge and fog computing concepts for real-time traffic decision-making, Network design considerations for resilience, latency, and efficiency			
III	**Machine Learning and Data Analytics in Transportation Systems** Use of large datasets in transport planning and operations, Application of artificial intelligence and predictive modelling in traffic forecasting, Pattern recognition and anomaly detection in transport data, Tools and techniques for visualizing mobility and congestion trends	8	L4	CO3
IV	**Integrated Traffic and Mobility Management Systems** Components of modern traffic control and traveller information systems, Design and operation of public and freight mobility platforms, Simulation of traffic conditions using standard software platforms, Strategies for improving coordination across multiple modes of transport	8	L5	CO4
V	**Policy, Ethics, and Cybersecurity in Intelligent Transportation** Legal and policy frameworks for intelligent transportation development in India and abroad, Ethical issues in automation, surveillance, and artificial intelligence in mobility, Data security, infrastructure protection, and risk mitigation strategies, Integration of intelligent systems in infrastructure projects through public-private collaboration	7	L4	CO5
Total		**39**		

Text Books

- Intelligent Transport Systems: Technologies and Applications – Bob McQueen & Joe Hernandez
- ITS Architecture and Standards – U.S. Department of Transportation Publications
- Big Data Analytics in Transportation Systems – Mashrur Chowdhury, Amy Apon, Kakan Dey

Reference Books:

- Smart Cities and Urban Mobility – Pierluigi Coppola & Domenico Silvestri
- Connected and Automated Vehicles: Data, Networks & Ethics – James M. Anderson et al.
- IEEE ITS Society Research Reports
- Government of India Reports on Smart Mobility (NITI Aayog, MoRTH)

Additional Learning Activities:

- Case Study on Local ITS Projects
- Students analyse real-world Intelligent Transportation Systems like Pune BRTS or Nagpur Metro, focusing on system components, commuter feedback, and practical challenges.
- Mini Project: Smart Mobility Plan for a Semi-Urban Area
- Students design an ITS-based transport improvement plan for a rural or tier-3 town in Maharashtra, incorporating local transport modes, digital payments, and real-time info in Marathi.
- Traffic Simulation Workshop Using Local Data
- Using tools like SUMO or QGIS, students simulate traffic flow for cities like Nashik or Aurangabad and evaluate the impact of smart signal control and routing strategies.

Poster or Infographic Presentation on ITS for Rural Maharashtra Students create visual presentations that highlight how ITS can support school transport, agriculture logistics, or emergency services in less urbanized regions of the state.

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Program:	**First Year M. Tech. (Civil Engineering)**			**Semester: I**				
Course:	**Finite Element Methods**			**Code: T25BFEM505**				
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**				
				Continuous Assessment				
	Lecture	**Practical**	**Tutorial**	**TT 1**	**TT 2**	**Internal Assessment**	**ESE**	**Total**
03	**03**	**-**	**-**	**20**	**20**	**40**	**60**	**100**

Course Objectives:

- To introduce the fundamental concepts and mathematical formulations of the finite element method.
- To develop the ability to derive element stiffness matrices using energy principles and weighted residual methods.
- To analyze structural components such as bars, beams, trusses, frames, and plates using FEM.
- To understand isoperimetric elements, numerical integration, and convergence requirements.
- To apply FEM for complex structural problems including dynamic and nonlinear analysis using commercial software.

Course Outcomes:

After completing the course, students will be able to:

CO1: Formulate and solve basic structural problems using finite element procedures.

CO2: Derive stiffness matrices for various 1D, 2D, and 3D elements using variation approaches.

CO3: Apply FEM to analyze real-life structural members including beams, trusses, and plates under different loading conditions.

CO4: Understand and implement isoperimetric formulation and numerical integration techniques.

CO5: Utilize commercial FEM software for structural analysis and interpret simulation results.

Detailed Syllabus

Unit	Description	Duration (Hrs.)	BL	CO
I	**Introduction to Finite Element Method:** Basic concepts of FEM, Steps in finite element analysis, Discretization of domain, Types of elements and nodes, Degrees of freedom, Shape functions and interpolation, Stiffness matrix formulation for 1D bar and truss elements, Assembly process and boundary conditions	8	L3	CO1
II	**Formulation Techniques and Element Types:** Principle of minimum potential energy, Galerkin's method, 1D elements: bar, beam, 2D elements: triangular (CST), quadrilateral (Q4), 3D elements: tetrahedral, hexahedral, Natural coordinate system and isoparametric formulation, Convergence, compatibility, and completeness requirements	8	L4	CO2
III	**Analysis of Structural Elements:** Axial deformation of bars, Beam and frame element formulation, Truss analysis (plane and space), Plane frame and space frame analysis, Global stiffness matrix formation, Load vector and boundary condition application, Static condensation and symmetry	8	L4	CO3
IV	**Two-Dimensional Problems and Plate Analysis:** Plane stress and plane strain problems, CST and quadrilateral element formulations, Plate bending theories: Kirchhoff and Mindlin, Finite element formulation for plates, Numerical integration (Gauss quadrature), Stress recovery techniques, Applications to slabs and shear walls	8	L5	CO4
V	**Advanced Topics and Applications:** Geometric and material nonlinearity, Introduction to dynamic problems, Time integration methods: Newmark, Thermal stress and coupled field problems, Software-based FEM (ANSYS, ABAQUS, NASTRAN), Real-life case studies and post-processing	7	L6	CO5

Total	39		

Text Books

- J. N. Reddy, An Introduction to the Finite Element Method, 3rd ed., New York, NY: McGraw-Hill, 2005
- C. S. Krishnamoorthy, Finite Element Analysis: Theory and Programming, 2nd ed., New Delhi, India: Tata McGraw-Hill, 1995.

Reference Books:

- O. C. Zienkiewicz, R. L. Taylor, and J. Z. Zhu, The Finite Element Method: Its Basis and Fundamentals, 7th ed., Oxford, U.K.: Butterworth-Heinemann, 2013.
- T. R. Chandrupatla and A. D. Belegundu, Introduction to Finite Elements in Engineering, 4th ed., Pearson Education, 2011.
- K. H. Huebner, D. L. Dewhirst, D. E. Smith, and T. G. Byrom, The Finite Element Method for Engineers, 4th ed., New York, NY: Wiley, 2001.
- R. D. Cook, D. S. Malkus, M. E. Plesha, and R. J. Witt, Concepts and Applications of Finite Element Analysis, 4th ed., New York, NY: Wiley, 2002.

Digital Resources:

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Program:	**First Year M. Tech. (Civil Engineering)**			**Semester: I**				
Course:	**Sustainable Concrete Technology**			**Code: T25BSCT505**				
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**				
				Continuous Assessment			**ESE**	**Total**
	Lecture	**Practical**	**Tutorial**	**TT 1**	**TT 2**	**Internal Assessment**		
03	**03**	**-**	**-**	**20**	**20**	**40**	**60**	**100**

Course Objectives:

- Equip students with the knowledge and tools required for designing and implementing sustainable concrete solutions.
- Explore eco-friendly materials, innovative mix designs, and durability enhancements that minimize the environmental impact of concrete structures.
- Provide a framework for assessing the sustainability of concrete projects through life-cycle analysis and performance evaluation.

- Prepare students to address the challenges in construction while promoting responsible and efficient use of resources.

Course Outcomes:

After completing the course, students will be able to:

CO1: Students will be able to explain the significance, environmental impacts, and regulatory aspects of sustainable concrete in modern construction.

CO2: Students will be able to identify and evaluate various eco-friendly materials and their potential applications in sustainable concrete.

CO3: Students will be able to design concrete mixes that optimize performance, durability, and sustainability using appropriate materials and proportioning methods.

CO4: Students will be able to assess and ensure the durability and long-term performance of sustainable concrete structures under various environmental conditions.

CO5: Students will be able to apply sustainable concrete technologies in real-world projects and explore emerging trends, innovations, and research in the field.

Detailed Syllabus

Unit	Description	Duration (Hrs.)	BL	CO
I	**Introduction to Sustainable Concrete** Fundamentals of Sustainable Concrete, Environmental Impact of Concrete Production, Sustainable Construction Practices, Regulatory Framework and Standards, Challenges and Opportunities.	8	L2	CO1
II	**Eco-Friendly Materials in Concrete** Supplementary Cementitious Materials (SCMs), Recycled Aggregates and Waste Materials, Natural and Alternative Aggregates, Chemical Admixtures for Sustainability, Bio-based and Innovative Materials, Durability Considerations in Material Selection, Performance Evaluation of Sustainable Materials, Case Studies of Sustainable Materials in Concrete	8	L3	CO2
III	**Green Concrete Mix Design** Principles of Mix Design, Low-Carbon and High-Performance Mixes, Optimization Techniques, Durability Considerations in Mix Design, Quality Control and Assurance, Mix Design for Special Applications, Sustainability Assessment Tools, Case Studies of Sustainable Mix Designs	8	L4	CO3
IV	**Durability and Performance of Sustainable Concrete** Durability Aspects, Performance Evaluation, Case Studies of Durable Sustainable Concrete, Maintenance and Repair Strategies, Innovations in Durability Enhancement, Performance Monitoring	8	L5	CO4

	and Management, Sustainability and Durability Synergy, Policy and Regulatory Considerations.			
V	**Applications and Future Trends** Real-World Applications, Emerging Technologies, Smart and Intelligent Concrete, Policy and Regulatory Framework, Research and Development Trends, Global Perspectives, Industry Collaboration and Innovation	7	L5	CO5
Total		**39**		

Text Books

- Concrete Technology: Theory and Practice" by M.S. Shetty
- Sustainable Concrete Materials" by J. Khatib
- Advanced Concrete Technology" by John Newman & Ban Seng Choo

Reference Books:

- Sustainable Construction Materials: Design and Applications – M. Ramachandran
- Fly Ash in Concrete: Production, Properties and Uses – V.M. Malhotra
- Durability of Concrete and Cement Composites – M.L. Gambhir
- Design and Control of Concrete Mixtures – Portland Cement Association (PCA)
- Sustainable Built Environment: Principles and Practice – S. P. C. Rao

Digital Resources:

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Program:	**First Year M. Tech.**			**Semester: I**		
Course:	**Research & Analytics (RA)**			**Code: T25BRA506**		
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**		
	Lecture	**Practical**	**Tutorial**	**TW**	**PR & OR**	**Total**
02	**-**	**02**	**-**	**50**	**50**	**100**

Course Objectives:

This course aims at enabling students:

- To develop understanding of statistical and analytical methods for civil engineering research.
- To enable analysis and interpretation of real-world civil engineering datasets.
- To promote skills in conducting and presenting research-based mini projects.
- To provide exposure to modern tools and software for data-driven research.

Course Outcomes:

After learning the course, the students will be able to:

- Apply statistical and analytical tools for research in civil engineering.
- Analyze and interpret real-world datasets relevant to civil engineering.
- Develop and present research-based mini-projects.
- Use modern tools and software for conducting data-driven research.

Guidelines for Students:

The laboratory practical is to be submitted by students in the form of a journal.

- Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each practical.
- Each assignment write-up should have Title, Objectives, out comes, Theory- Concept in brief, and Conclusion.

Guidelines for Laboratory/Term Work Assessment:

- Continuous assessment of laboratory work is based on overall performance and Laboratory practical performance of student.
- Each Laboratory practical assessment will assign grade/marks based on parameters with appropriate weightage.
- Suggested parameters for overall assessment as well as each Laboratory practical assessment include- timely completion, performance, innovation, efficient codes, punctuality, and neatness**.**

Guidelines for Laboratory Conduction

- Understand the Theory Behind the Experiment.
- Ensure Proper Setup and Calibration of Equipment.
- Follow Safety Protocols and Best Practices
- Collect data systematically, ensuring accuracy in measurements.

Record all observations and results promptly and clearly in the lab notebook.

Detailed Syllabus

Experiment No.	Practical	BL	CO
1.	Introduction to Research and Analytics Tools Installation and basic usage of Python (Anaconda), RStudio, or MATLAB. Introduction to data structures, libraries (NumPy, Pandas, Matplotlib). Overview of research methodology and data types in civil engineering.	L2	CO1
2.	Data Collection and Cleaning Importing datasets from CSV, Excel, online sources. Handling missing data, outliers, and data transformation. Data preprocessing techniques (normalization, encoding, etc.).	L3	CO1
3.	**Descriptive Statistics and Visualization | Summary statistics (mean, median, standard deviation, skewness, kurtosis). Visualizations: histograms, boxplots, scatter plots, heatmaps.**	L3	CO2

	Use of tools like Tableau/Power BI for interactive visualization.		
4.	Correlation and Regression Analysis Pearson and Spearman correlation. Linear and Multiple Linear Regression in Python/R. Case studies from transportation, geotechnical or structural data.	L3	CO2
5.	Hypothesis Testing and ANOVA t-tests (one-sample, two-sample), chi-square test. ANOVA for comparing means across groups. Interpretation of p-values and confidence intervals.	L4	CO3
6.	Time Series and Trend Analysis Time series decomposition. Trend estimation and smoothing techniques. Application in rainfall data, traffic flow, etc.	L4	CO3
7.	Machine Learning Basics (optional advanced module) Introduction to supervised and unsupervised learning. Simple regression/classification using scikit-learn or R. Case study: traffic prediction, structural failure detection.	L4	CO2
8.	Mini Project Select a dataset relevant to civil engineering (transportation, water resources, structural health, etc.). Apply analytics tools learned in the lab to perform a research analysis. Present findings via a report and/or oral presentation.	L5	CO3,4
	References: **Recommended Books** • Montgomery, D. C., & Runger, G. C. Applied Statistics and Probability for Engineers Wiley, 7th Edition, 2018. ISBN: 978-1119409533 • Navidi, W. Statistics for Engineers and Scientists, McGraw-Hill Education, 5th Edition, 2019. ISBN: 978-1259707925 • Gupta, S.C., & Kapoor, V.K. Fundamentals of Mathematical Statistics Sultan Chand & Sons, Latest Edition. ISBN: 978-8180540040 • Jain, R.K., & Narayan, M. A Textbook of Research Methodology, APH Publishing, Latest Edition., ISBN: 978-8176483842		
	Reference Books:		

	• Box, G. E. P., Hunter, W. G., & Hunter, J. S. Statistics for Experimenters: Design, Innovation, and Discovery Wiley, 2nd Edition, 2005. ISBN: 978-0471718130 • Field, A. Discovering Statistics Using IBM SPSS Statistics, SAGE Publications, 5th Edition, 2017. ISBN: 978-1526419521 • Zikmund, W. G., Babin, B. J., Carr, J. C., & Griffin, M. Business Research Methods, Cengage Learning, 9th Edition, 2012. ISBN: 978-1111826925 • Runkler, T. A. Data Analytics: Models and Algorithms for Intelligent Data Analysis Springer, 2nd Edition, 2016. ISBN: 978-3662492746
	Digital Content: NPTEL Online Courses • Data Science for Engineers by Prof. Raghunathan, IIT Madras • Introduction to Research by Prof. Deepankar Tewari, IIT Kanpur • Website: https://nptel.ac.in Coursera / edX / Udemy • Statistics with Python Specialization – University of Michigan (Coursera) • Data Analytics for Engineers – IIT Bombay on edX • Research Methodology – Dr. Pooja Sharma (Udemy) Kaggle Datasets • Access civil engineering-related open datasets (e.g., rainfall, traffic, structural monitoring) • Website: https://www.kaggle.com Tableau Public & Power BI Learning Portals • https://public.tableau.com https://learn.microsoft.com/en-us/power-bi

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Program:	**First Year M. Tech. (Civil Engineering)**			**Semester: I**		
Course:	**Emerging Trends in Civil Engineering**			**Code: T25BET507**		
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**		
	Lecture	**Practical**	**Tutorial**	**TW**	**PR & OR**	**Total**
01	**-**	**02**	**-**	**50**	**--**	**50**

Course Objectives:

This course aims at enabling students:

- To introduce contemporary trends and emerging technologies in civil engineering.
- To develop the ability to evaluate applications of new technologies in real-world problems.
- To encourage preparation of mini-projects or seminar presentations based on studies and applications.
- To enhance communication and technical documentation skills.

Course Outcomes:

After learning the course, the students will be able to:

- Identify and describe contemporary trends and technologies in Civil Engineering.
- Evaluate the potential application of emerging technologies in real-world civil engineering problems.
- Develop a mini-project or seminar presentation based on literature, case studies, or software application.
- Demonstrate enhanced communication and technical documentation skills.

Guidelines for Students:

The laboratory practical is to be submitted by students in the form of a journal.

- Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each practical.
- Each assignment write-up should have Title, Objectives, out comes, Theory- Concept in brief, and Conclusion.

Guidelines for Laboratory/Term Work Assessment:

- Continuous assessment of laboratory work is based on overall performance and Laboratory practical performance of student.
- Each Laboratory practical assessment will assign grade/marks based on parameters with appropriate weightage.
- Suggested parameters for overall assessment as well as each Laboratory practical assessment include- timely completion, performance, innovation, efficient codes, punctuality, and neatness**.**

Guidelines for Laboratory Conduction

- Understand the Theory Behind the Experiment.
- Ensure Proper Setup and Calibration of Equipment.
- Follow Safety Protocols and Best Practices
- Collect data systematically, ensuring accuracy in measurements.

Record all observations and results promptly and clearly in the lab notebook.

Detailed Syllabus

Title	**Experiment**	**BL**	**CO**
Introduction to Emerging Trends	Seminar/discussion on major shifts in civil engineering (AI, IoT, Sustainability, etc.)	**L2,L3,L4**	**CO1, CO2, CO3, CO4.**
Smart Materials and Nanotechnology	Case study on smart concrete, self-healing materials, nanomaterials in construction		
Digitalization in Civil Engineering	Hands-on introduction to BIM, GIS, digital twins, and drones in surveying		
Sustainable and Green Technologies	Study and debate on green buildings, carbon-neutral construction, LEED/IGBC rating systems		
3D Printing and Modular Construction	Group research on automation, prefab construction, and case studies of successful projects		
Artificial Intelligence & Machine Learning in Civil	Exploratory project using Python or MATLAB to predict/monitor infrastructure behavior		

	Engineering			
	Resilient and Smart Infrastructure	Discussion on earthquake-resistant structures, flood-resilient roads, smart traffic systems		
	Mini Project / Seminar Presentation	Individual or group presentation on selected emerging technology; submission of technical report		

References:

Recommended Books

- M.L. Gambhir – Modern Trends in Concrete Technology and Construction
- ISRO, DST, IRC and MORTH Reports on Infrastructure Innovation
- IS/IRC Codes and Guidelines (Latest) on Smart Roads, Bridges, and Green Construction

Online Learning

- NPTEL Courses: Smart Materials, BIM for Infrastructure Projects, AI for Civil Engineers
- McKinsey Reports on Infrastructure and Technology
- BIS Portal for latest Indian Standards

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CURRICULUM STRUCTURE

First Year M. Tech. (Civil Engineering) Semester – II

Program:	**First Year M. Tech. (Civil Engineering)**			**Semester: II**				
Course:	**AI & Machine Learning in Civil Engineering**			**Code: T25BAM551**				
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**				
	Lecture	**Practical**	**Tutorial**	**Continuous Assessment**			**ESE**	**Total**
				TT 1	**TT 2**	**Internal Assessment**		
03	**03**	**-**	**-**	**20**	**20**	**40**	**60**	**100**

Course Objectives:

- To understand fundamental concepts of Artificial Intelligence and Machine Learning.
- To apply ML techniques for solving civil engineering problems.
- To develop predictive models for structural, geotechnical, transportation, and environmental systems.

- To analyse civil engineering datasets using Python-based tools.
- To explore advanced AI techniques for smart infrastructure and decision-making.

Course Outcomes:

After completing the course, students will be able to:

- CO1: Utilize AI & ML concepts and their relevance to civil engineering.
- CO2: Implement regression and classification algorithms to predict civil engineering parameters.
- CO3: Apply clustering and dimensionality reduction techniques to group similar engineering data in high-dimensional civil engineering datasets.
- CO4: Implement neural networks for detecting and localizing defects like cracks, potholes, and structural damage from digital images.
- CO5: Interpret AI-driven solutions and optimization strategies for multidisciplinary civil engineering challenges

Detailed Syllabus

Unit	Description	Duration (Hrs.)	BL	CO
I	Module 1: Introduction to AI & Data Science in Civil Engineering- Overview of Artificial Intelligence and Machine Learning, Types of ML: Supervised, Unsupervised, Reinforcement Learning, Role of AI in Civil Engineering, Data types in civil engineering (structured/unstructured), Data collection: Sensors, IoT, Remote sensing, GIS, Data preprocessing: Cleaning, normalization, feature selection	8	L3	CO1
II	Module 2: Supervised Learning Techniques- Regression: Linear, Multiple, Polynomial, Classification: Logistic Regression, k-NN, Decision Trees, Support Vector Machines (SVM),Model evaluation: RMSE, MAE, R^2, Confusion Matrix	8	L3	CO2
III	Module 3: Unsupervised Learning & Clustering- Clustering: k-Means, Hierarchical clustering, Dimensionality reduction: PCA, Anomaly detection	8	L3	CO3
IV	Module 4: Deep Learning & Computer Vision- Introduction to Neural Networks, ANN, CNN basics, Image processing for civil engineering, Object detection (cracks, potholes, defects)	8	L3	CO4
V	Module 5: Advanced Applications & Case Studies - AI in Structural Engineering (optimization, design), AI in Geotechnical Engineering (settlement prediction), AI in Transportation (traffic prediction, smart signals), AI in Environmental Engineering (water quality, pollution), Reinforcement Learning for resource optimization, Case studies and mini project	7	L4	CO5
Total		**39**		

Text Books

1. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
2. Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.
3. Stuart Russell, Peter Norvig, Artificial Intelligence: A Modern Approach, 4th Edition, Pearson Education, 2020.
4. Andries Engelbrecht, Computational Intelligence: An Introduction, 2nd Edition, Wiley, 2007.

Reference Books:

1. K.P. Soman, R. Longonathan and V. Vijay, Machine Learning with SVM and Other Kernel Methods, PHI-2009
2. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer 2006.
3. Shalev-Shwartz,S., Ben-David,S., (2014), Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press
4. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
5. Kishan Mehrotra, Chilukuri Mohan and Sanjay Ranka, Elements of Artificial Neural Networks, Penram International
6. Rajjan Shinghal, Pattern Recognition, Techniques and Applications, OXFORD
7. Kevin Warwick, Artificial Intelligence Techniques in Power Systems, IET Publications.

Digital Resources:

Introduction to Machine Learning, By Prof. Balaraman Ravindran , IIT Madras
https://nptel.ac.in/courses/106106139

Prepared by **Verified by** **M. Tech. Coordinator** **HOD** **Dean**

Program:	**First Year M. Tech. (Civil Engineering)**				**Semester: II**	
Course:	**Artificial Intelligence Lab**				**Code: T25BAI551L**	
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**		
	Lecture	**Practical**	**Tutorial**	**TW**	**PR & OR**	**Total**
02	**-**	**02**	**-**	**25**	**25**	**50**

Course Objectives:

This course aims at enabling students:

- Develop practical understanding of AI and Machine Learning tools for civil engineering applications.
- Train students in data pre-processing, visualization, and predictive analytics using Python.
- Implement supervised and unsupervised learning algorithms on civil engineering datasets.
- Apply deep learning and computer vision techniques for infrastructure assessment.

Analyze and interpret engineering data for intelligent decision-making.

Course Outcomes:

After learning the course, the students will be able to:

CO1: Perform pre-processing and visualization of civil engineering datasets using Python tools.
CO2: Develop regression and classification models for civil engineering applications.
CO3: Apply clustering and dimensionality reduction methods for engineering data analysis.

CO4: Implement neural network and computer vision techniques for defect detection.
CO5: Design AI-based solutions for multidisciplinary civil engineering problems.

Guidelines for Students:

The laboratory practical is to be submitted by students in the form of a journal.

- Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each practical.
- Each assignment write-up should have Title, Objectives, out comes, Theory- Concept in brief, and Conclusion.

Guidelines for Laboratory/Term Work Assessment:

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Guidelines for Laboratory Conduction

- Understand the Theory Behind the Experiment.
- Ensure Proper Setup and Calibration of Equipment.
- Follow Safety Protocols and Best Practices
- Collect data systematically, ensuring accuracy in measurements.

Record all observations and results promptly and clearly in the lab notebook.

Detailed Syllabus

Experiment No.	Practical	BL	CO
Section: A (Compulsory)			
1.	Study of Python libraries for AI & Machine Learning applications in Civil Engineering using NumPy, Pandas, Matplotlib, and Scikit-learn.	**BL2,3,4,5**	CO1,2,3,4,5,
2.	Data pre-processing and visualization of civil engineering datasets including handling missing data, normalization, and feature scaling.		
3.	Development of Linear Regression model for prediction of concrete compressive strength.		
4.	Multiple Regression analysis for traffic flow prediction and pavement performance evaluation.		
5.	Polynomial Regression model for prediction of settlement behaviour in geotechnical engineering.		
6.	Logistic Regression model for classification of water quality status.		
7.	Implementation of k-Nearest Neighbour (k-NN) algorithm for soil classification.		
8.	Decision Tree model for accident severity prediction in transportation engineering.		

9.	Support Vector Machine (SVM) for structural health monitoring and crack classification.		
10.	Clustering of urban traffic patterns using k-Means clustering.		
11.	Principal Component Analysis (PCA) for dimensionality reduction of environmental engineering datasets.		
12.	Development of Artificial Neural Network (ANN) model for prediction of structural response.		
13.	Image-based crack detection using Convolutional Neural Networks (CNN) and OpenCV.		
Section: A (Any TWO)			
14.	Smart traffic signal optimization using Reinforcement Learning concepts.	**BL2,3,4,5**	CO1,2,3,4,5,
15.	AI-based pothole detection and localization using image processing techniques.		
16.	Prediction of air or water pollution levels using Machine Learning models.		
17.	AI-enabled flood prediction using rainfall and hydrological datasets.		
18.	Mini Project based on AI applications in Structural, Transportation, Environmental, or Geotechnical Engineering.		
19.	Smart traffic signal optimization using Reinforcement Learning concepts.		
20.	AI-based pothole detection and localization using image processing techniques.		
	Text Books: • Tom Mitchell, Machine Learning, First Edition, McGraw-Hill, 1997. • Introduction to Machine Learning, MIT Press, 2020. • Artificial Intelligence: A Modern Approach, 4th Edition, Pearson Education, 2020. • Computational Intelligence: An Introduction, 2nd Edition, Wiley, 2007. • Python Machine Learning, 3rd Edition, Packt Publishing, 2019. • Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow, 3rd Edition, O'Reilly Media, 2022. • Deep Learning, MIT Press, 2016. • Data Science for Engineers, Springer, 2021.		
	Reference Books: • Pattern Recognition and Machine Learning, Springer, 2006. • Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press, 2014. • Machine Learning: A Probabilistic Perspective, MIT Press, 2012. • Elements of Artificial Neural Networks, Penram International Publishing.		

	• Pattern Recognition: Techniques and Applications, Oxford University Press. • Machine Learning with SVM and Other Kernel Methods, PHI Learning, 2009. • Deep Learning with Python, Manning Publications, 2021. • Artificial Intelligence Techniques in Power Systems, IET Publications. • Computer Vision with OpenCV, O'Reilly Media. • Data Analytics for Civil Engineers, ICE Publishing.
	Software and Tools Required: • Python Programming Environment (Anaconda / Jupyter Notebook / Google Colab) • NumPy, Pandas, Matplotlib, Seaborn • Scikit-learn • TensorFlow / Keras • OpenCV GIS datasets / Civil Engineering datasets
	Suggested Civil Engineering Datasets: • Concrete Compressive Strength Dataset • Traffic Volume Count Dataset • Pavement Condition Dataset • Water Quality Dataset • Structural Crack Image Dataset • Air Pollution Monitoring Dataset Rainfall and Flood Data Records
	Guidelines for Laboratory Work: • Students shall maintain a certified journal with problem statements, algorithms, code, outputs, and interpretations. • Each experiment shall include dataset analysis, model implementation, result evaluation, and engineering interpretation. • Mini project work should address a real-world civil engineering problem using AI/ML techniques. • Use of Python-based open-source tools is mandatory.

Prepared by Verified by M. Tech. Coordinator HOD Dean

Program:	**First Year M. Tech. (Civil Engineering)**						**Semester: II**	
Course:	**Water Resources & Climate Resilience**						**Code: T25BWR552**	
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**				
				Continuous Assessment				
	Lecture	**Practical**	**Tutorial**	**TT 1**	**TT 2**	**Internal Assessment**	**ESE**	**Total**
03	**03**	**-**	**-**	**20**	**20**	**40**	**60**	**100**

Course Objectives:

- To understand climate systems and their influence on hydrology.
- To analyze climate change impacts on water resources.
- To apply climate and hydrologic models for future assessment.
- To evaluate climate adaptation strategies in water management.

Course Outcomes:

After completing the course, students will be able to:

CO1: Explain climate systems and climate change drivers
CO2: Analyze climate change impacts on hydrological processes
CO3: Apply climate and hydrologic models for water resource assessment
CO4: Analyze uncertainty and probabilistic approaches in climate projections
CO5: Analyze adaptation strategies for climate-resilient water systems

Detailed Syllabus

Unit	Description	Duration (Hrs.)	BL	CO
I	Climate Science Fundamentals Climate vs Weather, Climatic classification, Drivers of climate change, Overview of changing climate, Climate data analysis, Climate forecasting basics	8	2	CO1
II	Hydrologic System and Climate Interaction Hydrologic cycle, Water budget, Rainfall & temperature variability, Impact on runoff, ET, soil moisture, groundwater, Soil/sediment impact, Droughts and floods	8	3	CO2
III	Climate Modeling and Scenarios Climate forecasting approaches, GCM and RCM, Downscaling techniques, Future climate scenarios (RCPs/SSPs)	8	3	CO3
IV	Water Resources Assessment Surface water, groundwater, soil moisture assessment, Vulnerability concepts (introductory, no evaluation), Hydrologic models (SWAT, HEC-HMS), Calibration and validation, Probabilistic interpretation of results	8	4	CO4
V	Climate Resilience and Adaptation Adaptation concepts and capacity, Sensitivity analysis Climate-resilient water management: Reservoirs, Surface water, Groundwater, Policy overview	7	4	CO5
Total		**39**		

Text Books

- K. S. Raju and D. Nagesh Kumar, Impact of Climate Change on Water Resources, Springer, 2018.
- Ven Te Chow, David R. Maidment and Larry W. Mays, Applied Hydrology, McGraw Hill, 2017.

S. Lawrence Dingman, Physical Hydrology, 3rd Edition, Waveland Press, 2015.

Reference Books:

1. Wilby, R. L. and Dawson, C. W., Statistical Downscaling and Hydrological Modelling, Wiley, 2013.
2. Vijay P. Singh, Hydrology and Climate Change, Springer, 2014.
3. Kundzewicz, Z. W. (Ed.), Climate Change and Water Resources, CRC Press, 2007.
4. Subramanya, K., Engineering Hydrology, 4th Edition, McGraw Hill Education, 2017.

IPCC, Climate Change Assessment Reports, Intergovernmental Panel on Climate Change (Latest Editions).

Digital Resources:

Prepared by **Verified by** **M. Tech. Coordinator** **HOD** **Dean**

Program:	**First Year M. Tech. (Civil Engineering)**			**Semester: II**		
Course:	**Hydrology & Water Quality Lab**			**Code: T25BHW552L**		
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**		
	Lecture	**Practical**	**Tutorial**	**TW**	**PR & OR**	**Total**
02	**-**	**02**	**-**	**25**	**25**	**50**

Course Objectives:

This course aims at enabling students:

- To develop practical skills in analysis of water and wastewater quality parameters using standard methods and advanced instruments.
- To enable students to interpret water quality data with respect to environmental and regulatory standards.
- To provide exposure to hydrological and hydraulic modeling tools used in water resources engineering.
- To train students in use of real-time and open-source datasets for environmental analysis.
- To integrate laboratory analysis and modeling approaches for sustainable water resource management

Course Outcomes:

After learning the course, the students will be able to:

- Analyze physicochemical and biological characteristics of water and wastewater using laboratory methods and instruments.
- Interpret water quality results to assess compliance with environmental standards
- Apply hydrological and water quality models for analysis of water systems
- Apply open-source and real-time data for water resource analysis and decision-making
- Evaluate relationships between hydrology and water quality to propose sustainable solutions

Guidelines for Students:

The laboratory practical is to be submitted by students in the form of a journal.

- Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each practical.
- Each assignment write-up should have Title, Objectives, out comes, Theory- Concept in brief, and Conclusion.

Guidelines for Laboratory/Term Work Assessment:

- Continuous assessment of laboratory work is based on overall performance and Laboratory practical performance of student.
- Each Laboratory practical assessment will assign grade/marks based on parameters with appropriate weightage.
- Suggested parameters for overall assessment as well as each Laboratory practical assessment include- timely completion, performance, innovation, efficient codes, punctuality, and neatness**.**

Guidelines for Laboratory Conduction

- Understand the Theory Behind the Experiment.
- Ensure Proper Setup and Calibration of Equipment.
- Follow Safety Protocols and Best Practices
- Collect data systematically, ensuring accuracy in measurements.
- Record all observations and results promptly and clearly in the lab notebook.

Detailed Syllabus

Experiment No.	Practical	BL	CO
	Section. A Hydrology		
1	Water Distribution Networks: Design and analysis of water distribution networks using EPANET	L4	CO3,5
2	Open Source Data: Downloading and using data from various open sources	L3	CO4
3	HEC-HMS: Event based flood modelling using HEC-HMS	L4	CO3,4
4	HEC-RAS: Flood inundation mapping using HEC-RAS	L4	CO3,4
5	SWAT: Continuous simulation modelling using SWAT	L4	CO3,4
6	SWMM: Design and analysis of storm water drainage network using SWMM	L4	CO3,4
	Section. B Water Quality		
7	Determination of physical characteristics of an unknown water and wastewater sample.	L3	CO1,2
8	Determination of chemical characteristics of an unknown water and wastewater sample.	L3	CO1,2
9	Determination of biological characteristics of an unknown water and wastewater sample.	L3	CO1,2
10	Determination of sulphate, fluoride and iron content in an unknown water sample using Spectrophotometer.	L3	CO1,2
11	Determination of Sodium and Potassium ions using flame photometer in an unknown water sample.	L3	CO1,2
12	Determination of Heavy Metals (Lead (Pb), Cadmium (Cd), Arsenic (As), Mercury (Hg)) Using Atomic Absorption Spectroscopy.	L3	CO1,2

Section. C Water Quality Modelling			
13	Water Quality Modelling using QUAL2K/WEAP	L4	CO3
14	Sensor-based Real-Time Monitoring (AI/ML-IoT Integration) and data analysis of water and wastewater properties.	L5	CO4,5
	References: **Recommended Books** **Text Books:** 1: Indian Standard DRINKING WATER: IS 10500:2012 2. Indian Standard IS:3025 various parts 3. Garg S. K., "Water Supply Engineering", Khanna Publishers, New Delhi		
	Reference Books: 1. CPCB Guide Manual Water and Wastewater Analysis. 2. Sharma and Kaur, "Environmental Chemistry", Goyal Publisher. 3. Publications by reputed organizations such as WHO, NEERI, MERI, MPCB, CWPRS.		
	Digital Content: • https://ee1-nitk.vlabs.ac.in/List%20of%20experiments.html • https://ee2-nitk.vlabs.ac.in/ • EPANET: Hydraulic modelling of water distribution piping system http://www2.epa.gov/waterresearch/epanet • HEC-HMS: Hydrologic Engineering Center- Hydrologic Modelling System • http://www.hec.usace.army.mil/software/hec-hms/ • HEC-RAS: Hydrologic Engineering Center River Analysis System • http://www.hec.usace.army.mil/software/hec-ras/ • SWAT: Soil and Water Assessment Tool http://swat.tamu.edu/ • SWMM: Storm Water Management Model http://www2.epa.gov/water-research/storm-watermanagement-model-swmm		
	Term Work: • Minimum 2 from section A, minimum 3 Practical from section B and minimum 1 Practical from section C shall be submitted. • A site visits to water and wastewater treatment plant followed by submission of sample analysis and design report. • Determination Water Quality Index of nearby region.		

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Program:	**First Year M. Tech. (Civil Engineering)**			**Semester: II**		
Course:	**Structural Dynamics**			**Code: T25BSD553**		
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**		
	Lecture	**Practi**	**Tutor**	**Continuous**	**ESE**	**Total**

		cal	ial	Assessment				
				TT 1	TT 2	Internal Assessment		
03	**03**	**-**	**-**	**20**	**20**	**40**	**60**	**100**

Course Objectives:

- To understand the fundamental principles governing the dynamic behavior of structures.
- To formulate and solve equations of motion for single and multi-degree-of-freedom systems.
- To analyze dynamic responses of structures under various loading types including harmonic, impulse, and seismic.
- To introduce concepts of continuous system dynamics and the application of FEM in dynamic problems.

To familiarize students with codal practices and software tools used in structural dynamic analysis.

Course Outcomes:

After completing the course, students will be able to:

CO 1: Distinguish between static and dynamic loading and formulate equations of motion for lumped and distributed systems using Newton's laws and Lagrangian mechanics.

CO 2: Analyze SDOF systems for free and forced vibrations to determine natural frequency, damping ratios, and response to base excitation using Duhamel's integral.

CO 3: Solve eigenvalue problems for MDOF systems to identify mode shapes and natural frequencies using modal superposition and matrix iteration methods.

CO 4: Evaluate the longitudinal and transverse vibrations of continuous beams and frames using Euler-Bernoulli theory and Finite Element Method (FEM) formulations.

CO 5: Design seismic-resistant structures by applying IS codal provisions, response spectrum methods, and advanced mitigation techniques like base isolation.

Detailed Syllabus

Unit	Description	Duration (Hrs.)	BL	CO
I	**Fundamentals of Structural Dynamics:** The basics of structural dynamics; differences between static and dynamic loading; modeling of lumped and distributed parameter systems; degrees of freedom; equations of motion using Newton's law, D'Alembert's principle, and Lagrangian mechanics; types of damping such as viscous, Coulomb, and structural	8	L3	CO1
II	**Single Degree of Freedom Systems (SDOF):** Free and forced vibrations; natural frequency; damping ratio; logarithmic decrement; critical	8	L4	CO2

	damping; resonance; Fourier series; Duhamel's integral; base excitation; transmissibility; and numerical methods			
III	**Multi-Degree of Freedom Systems (MDOF):** Equations of motion in matrix form; mass, stiffness, and damping matrices; eigenvalue problems; natural frequencies and mode shapes; orthogonality of modes; modal participation factors; modal superposition; matrix iteration; and software applications	8	L4	CO3
IV	**Continuous Systems and Structural Elements:** Longitudinal and transverse vibrations of beams; boundary conditions; Euler-Bernoulli beam theory; finite element method (FEM); lumped and consistent mass matrices; and dynamic behavior of beams, frames, and trusses	8	L4	CO4
V	**Earthquake Engineering and Structural Response:** Seismic loads; ground motion characteristics; design and response spectra; SDOF and MDOF seismic response; equivalent static and response spectrum methods; codal provisions (IS 1893, IS 13920); ductile detailing; base shear; base isolation; damping devices; and software-based seismic analysis with real-life case studies	7	L4	CO5
Total		**39**		

Text Books:

[1] A. K. Chopra, *Dynamics of Structures: Theory and Applications to Earthquake Engineering*, 4th ed., Pearson Education, 2017.

[2] R. W. Clough and J. Penzien, *Dynamics of Structures*, 3rd ed., Berkeley, CA: Computers and Structures, Inc., 2003.

[3] Mario Paz and William Leigh, Structural Dynamics-Theory and Computations, 5th ed., KlUWER Academic Publisher, London, 2004.

Reference Books:

[1] S. S. Rao, *Mechanical Vibrations*, 6th ed., Pearson Education, 2017.

[2] R. R. Craig and A. J. Kurdila, *Fundamentals of Structural Dynamics*, 2nd ed., Hoboken, NJ: Wiley, 2006.

[3] J. M. Biggs, *Introduction to Structural Dynamics*, New York, NY: McGraw-Hill, 1964.

[4] J. L. Humar, *Dynamics of Structures*, 3rd ed., Boca Raton, FL: CRC Press, 2012.

[5] V. K. Manicka Selvam, *Structural Dynamics: Vibrations and Systems*, ANE Books Pvt. Ltd., New Delhi, India: 2012.

[6] M. Mukhopadhyay, Vibrations, Dynamics and Structural Systems, CRC Press, Taylor & Francis Group, 2000.

Digital Resources:

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Program:	**First Year M. Tech. (Civil Engineering)**						**Semester: II**	
Course:	**Advanced Structural Design**						**Code: T25BAS553**	
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**				
				Continuous Assessment			**ESE**	**Total**
	Lecture	**Practical**	**Tutorial**	**TT 1**	**TT 2**	**Internal Assessment**		
03	**03**	**-**	**-**	**20**	**20**	**40**	**60**	**100**

Course Objectives:

- To understand the principles and applications of advanced structural systems under various loading conditions.
- To impart knowledge on the design of specialized structures such as water tanks, bunkers, silos, chimneys, and flat slabs.
- To familiarize students with relevant Indian Standard codes and design methodologies for both RCC and steel structures.
- To enhance the ability to analyze and design structures subjected to dynamic, hydrostatic, and earth pressures.
- To develop skills in reinforcement detailing, stability checks, and foundation design for advanced structures.

Course Outcomes:

After completing the course, students will be able to:

CO 1: Explain the scope of advanced structural design and apply relevant IS codal provisions for complex loading conditions including wind and seismic loads.

CO 2: Analyze and design steel bunkers and silos using Jansen's and Airy's theories, including components like stiffeners and hoppers.

CO 3: Determine load combinations and design steel chimneys, including the stability of base plates and foundation bolts.

CO 4: Design rectangular water tanks and RC Intz-type water tanks, including domes, ring girders, and staging with raft foundations.

CO 5: Propose designs and detailing for reinforced concrete flat slabs and deep beams using direct design and equivalent frame methods

Detailed Syllabus

Unit	**Description**	**Duration (Hrs.)**	**BL**	**CO**

I	**Introduction to Advanced Structural Design:** Scope and significance of advanced structural design, Comparison of working stress and limit state design methods, Overview of advanced loading conditions: Wind loads (as per IS:875 Part 3), Seismic loads (as per IS:1893), Temperature effects and shrinkage, Hydrostatic and earth pressure, Codal provisions and relevant IS codes, Introduction to fatigue, creep, and shrinkage in design	8	L3	CO1
II	**Bunkers and Silos:** Design of square bunker, Jansen's and Airy's theories, IS Codal provisions, Design of side plates, Stiffeners, Hooper, Longitudinal beams, Design of cylindrical silo, Side plates, Ring girder, stiffeners.	8	L4	CO2
III	**Chimneys:** Introduction, dimensions of steel stacks, chimney lining, breech openings and access ladder, loading and load combinations, design considerations, stability consideration, design of base plate, design of foundation bolts, design of foundation.	8	L4	CO3
IV	**Water Tanks**: Design of RC water tanks resting on grounds, Design of underground water tanks **RC Intz Tanks:** IS method of calculating shear forces and moments, Hoop tension, Design of intze tank Dome, Ring girders, Conical dome, Staging, Bracings and Raft foundation.	8	L4	CO4
V	**Design of Flat Slabs:** Introduction, Proportioning of Flat Slabs, Determination of Bending moment and Shear Force, Direct Design method, Equivalent Frame method, Slab Reinforcement. Design and Detailing of Reinforced Concrete Deep Beams	7	L4	CO5
Total		**39**		

Text Books:

[1] R. Subramanian, Design of Steel Structures, Oxford University Press, India, 2010.
[2] S. Ramamrutham and R. Narayan, Design of Reinforced Concrete Structures, Dhanpat Rai Publishing, 2021.
[3] N. Krishna Raju, Advanced Reinforced Concrete Design, CBS Publishers & Distributors, 2012.

Reference Books:

[1] S. K. Duggal, Limit State Design of Steel Structures, McGraw Hill Education, 2017.
[2] B. C. Punmia, A. K. Jain, and A. K. Jain, Limit State Design of Reinforced Concrete, Laxmi Publications, 2020.
[3] IS 456:2000, Plain and Reinforced Concrete – Code of Practice, BIS, New Delhi.
[4] IS 3370:2009, Code of Practice for Liquid Retaining Structures, BIS, New Delhi.
[5] IS 6533:1989 (Parts 1 and 2), Code of Practice for Design and Construction of Steel Chimneys, BIS, New Delhi.

Digital Resources:

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Program:	**First Year M. Tech. (Civil Engineering)**						**Semester: II**	
Course:	**Urban Flood Management & Drainage Systems**						**Code: T25BUF554**	
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**				
				Continuous Assessment			**ESE**	**Total**
	Lecture	**Practical**	**Tutorial**	**TT 1**	**TT 2**	**Internal Assessment**		
03	**03**	**-**	**-**	**20**	**20**	**40**	**60**	**100**

Course Objectives:

- To understand urban hydrological processes and flood mechanisms.
- To design urban drainage components and systems.
- To apply modeling techniques for flood analysis.
- To analyze sustainable and integrated urban flood management strategies.

Course Outcomes:

After completing the course, students will be able to:
CO1: Explain urban hydrology and drainage system concepts
CO2: Apply design principles for stormwater drainage systems
CO3: Analyze urban flood behavior using models
CO4: Apply BMPs and sustainable drainage techniques
CO5: Analyze urban flood management planning and economics

Detailed Syllabus

Unit	**Description**	**Duration (Hrs.)**	**BL**	**CO**
I	**Urban Hydrology and Flood Processes** Introduction to urban flood management and challenges, Impact of urbanization on hydrological cycle, Rainfall characteristics and design storm concepts (IDF curves), Rainfall–runoff relationships in urban areas (Rational method – basics), Time of concentration and peak discharge estimation, Types	8	L2	CO1

	of urban flooding (pluvial, fluvial)			
II	**Design of Urban Drainage Components** Principles of urban drainage system design, Design of stormwater inlets (types, spacing, capacity), Design of culverts (types and hydraulic considerations), Design of pumps and pumping stations, Basics of flow in open channels and closed conduits	8	L3	CO2
III	**Storage and Infiltration Systems** Detention and retention systems (concept and design basics), Estimation of storage volume and outlet structures, Design of infiltration systems (basins, trenches), Groundwater recharge concepts, Effect of storage systems on peak flow reduction	8	L4	CO3
IV	**Modeling and Sustainable Drainage** Introduction to urban drainage models (SWMM – overview), Model inputs, runoff estimation, and flow routing, Concept of calibration and validation, Best Management Practices (BMPs): structural and non-structural, Rainwater harvesting and low impact development (LID), Sediment and waste management in stormwater systems	8	L4	CO4
V	**Integrated Urban Flood Management** Management of urban lakes, rivers, and wetlands, Urban flood mitigation measures (structural and non-structural), Drainage master planning (concepts and approach), Economic analysis (basic cost considerations), Case studies of urban floods	7	L4	CO5
Total		**39**		

Text Books:

1. Akan, A. O. and Houghtalen, R. J., Urban Hydrology, Hydraulics and Stormwater Quality, Wiley, 2003.
2. Viessman, W., Lewis, G. L. and Knapp, J. W., Introduction to Hydrology, Pearson Education, 2017.
3. Gupta, K. and Saul, A. J., Urban Drainage, E & FN Spon, 1996.

Reference Books:

1. Butler, D. and Davies, J. W., Urban Drainage, 3rd Edition, CRC Press, 2011.
2. ASCE, Design and Construction of Urban Stormwater Management Systems, 1992.
3. Chow, V. T., Maidment, D. R. and Mays, L. W., Applied Hydrology, McGraw Hill, 2017.
4. EPA, Storm Water Management Model (SWMM) Manual.
5. CPHEEO, Manual on Sewerage and Sewage Treatment Systems, Government of India.

Digital Resources:

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Program:	**First Year M. Tech. (Civil Engineering)**						**Semester: II**	
Course:	**Hydraulic Structures & Coastal Engineering**						**Code: T25BHS554**	
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**				
				Continuous Assessment			**ESE**	**Total**
	Lecture	**Practical**	**Tutorial**	**TT 1**	**TT 2**	**Internal Assessment**		
03	**03**	**-**	**-**	**20**	**20**	**40**	**60**	**100**

Course Objectives:

- To understand planning, design, and analysis of hydraulic structures.
- To study river engineering and energy dissipation systems.
- To understand coastal processes and wave mechanics.
- To analyze coastal protection and offshore engineering systems.

Course Outcomes:

After completing the course, students will be able to:

CO1: Explain types and functions of hydraulic structures
CO2: Apply design principles of hydraulic structures
CO3: Analyze river behaviour and river training works
CO4: Explain coastal processes and wave mechanics
CO5: Analyze coastal protection structures and shoreline management

Detailed Syllabus

Unit	**Description**	**Duration (Hrs.)**	**BL**	**CO**
I	**Hydraulic Structures** Classification and functions of hydraulic structures, Forces acting on structures (water pressure, uplift, seepage), Gravity dams: components and basic stability considerations, Spillways: types and selection criteria, Energy dissipation: hydraulic jump, stilling basins	8	L2	CO1
II	**Design of Hydraulic Structures** Design of weirs and barrages, Canal headworks and control structures, Canal falls and cross drainage works, Seepage, uplift pressure, and drainage provisions, Failure modes and safety	8	L3	CO2

	considerations			
III	**River Engineering and Sediment Transport** River morphology and classification, Sediment transport: bed load and suspended load concepts, River training works: guide banks, groynes, levees, Riverbank protection methods, River stabilization and channel improvement	8	L4	CO3
IV	**Coastal Processes and Wave Mechanics** Coastal environment and shoreline processes, Wave generation and characteristics, Wave transformation: refraction, diffraction, reflection, Tides, storm surges, and coastal currents, Littoral drift and sediment transport	8	L2	CO4
V	**Coastal Engineering and Protection Structures** Coastal protection structures: Seawalls, breakwaters, groynes, Shoreline management and erosion control, Harbour and port planning basics, Offshore structures (introductory concepts), Case studies of coastal and hydraulic projects	7	L3	CO5
Total		**39**		

Text Books:

1. S. K. Garg, Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 2013.
2. Novak, P., Moffat, A. I. B., Nalluri, C. and Narayanan, R., Hydraulic Structures, CRC Press, 2017.
3. Sorensen, R. M., Basic Coastal Engineering, Springer, 2006.

Reference Books:

1. USACE, Coastal Engineering Manual, U.S. Army Corps of Engineers.
2. CERC, Shore Protection Manual, Coastal Engineering Research Center.
3. Chow, V. T., Maidment, D. R. and Mays, L. W., Applied Hydrology, McGraw Hill, 2017.
4. Mutreja, K. N., Applied Hydrology, Tata McGraw Hill, 2013.
5. Dean, R. G. and Dalrymple, R. A., Water Wave Mechanics for Engineers and Scientists, World Scientific, 1991.

Digital Resources:

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Program:	**First Year M. Tech. (Civil Engineering)**	**Semester: II**
Course:	**Environmental Impact Assessment**	**Code: T25BEI555**

Credit	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks				
				Continuous Assessment			ESE	Total
	Lecture	Practical	Tutorial	TT 1	TT 2	Internal Assessment		
03	03	-	-	20	20	40	60	100

Course Objectives:

- To understand the principles, procedures, and legal framework of Environmental Impact Assessment (EIA).
- To analyze environmental impacts of industrial, infrastructure, and developmental projects.
- To apply EIA methodologies, impact prediction techniques, and risk assessment tools.
- To evaluate environmental management practices and mitigation strategies for sustainable development.
- To develop Environmental Management Plans (EMP) and monitoring frameworks for environmental protection.

Course Outcomes:

After completing the course, students will be able to:

- Explain the concepts, objectives, and legal procedures of Environmental Impact Assessment.
- Analyze environmental impacts on physical, biological, and socio-economic systems due to developmental activities.
- Apply EIA methodologies, impact prediction, and risk assessment techniques for project evaluation.
- Analyze environmental legislation, public participation, and environmental management strategies in EIA studies.
- Develop Environmental Management Plans (EMP), mitigation measures, and monitoring programs for sustainable projects.

Detailed Syllabus

Unit	Description	Duration (Hrs.)	BL	CO
I	**Introduction to Environmental Impact Assessment** Concept, objectives, and scope of EIA, Evolution and history of EIA, Principles of sustainable development, Environmental components and indicators, Environmental policies and regulations in India, EIA Notification and clearance procedures, Role of stakeholders in EIA, Introduction to environmental auditing	8	L2	CO1
II	**EIA Process and Methodologies** Screening and scoping methods, Baseline environmental data collection, Impact identification techniques, Impact prediction methodologies, Checklist and matrix methods, Network and overlay methods, Quantitative and qualitative EIA techniques, Rapid EIA and Comprehensive EIA	8	L3	CO2

III	**Environmental Impact Analysis** Air pollution impact assessment, Water pollution impact assessment, Soil and land degradation assessment, Noise pollution assessment, Ecological and biodiversity impacts, Socio-economic and cultural impacts, Environmental risk and hazard assessment, Cumulative impact assessment	8	L3	CO3
IV	**Environmental Management and Monitoring** Environmental Management Plan (EMP), Mitigation measures for environmental impacts, Environmental monitoring techniques, Environmental auditing and reporting, Public participation and public hearing, Rehabilitation and resettlement (R&R), Environmental standards and compliance, ISO 14001 and environmental management systems	8	L4	CO4
V	**Applications of EIA and Case Studies** EIA for transportation projects, EIA for dams and water resource projects, EIA for thermal power plants, EIA for mining and industrial projects, Urban infrastructure and smart city projects, Climate change considerations in EIA, Life Cycle Assessment (LCA), National and international case studies on EIA	7	L4	CO5
Total		**39**		

Text Books

- Larry W. Canter – Environmental Impact Assessment
- John Glasson, Riki Therivel – Introduction to Environmental Impact Assessment
- Rau and Wooten – Environmental Impact Analysis Handbook
- Jain, Urban and Stacey – Environmental Impact Analysis
- B.B. Sundar – Environmental Impact Assessment and Management

Reference Books:

1. Indian Institute of Technology (IIT) Environmental Engineering Curriculum
2. MoEFCC Guidelines for Environmental Impact Assessment
3. CPCB Environmental Standards and Manuals
4. UNEP Environmental Assessment Guidelines
5. ISO 14001 Environmental Management System Documentation

Digital Resources:

- National Digital Library of India (NDLI)
- NPTEL Courses on Environmental Engineering and EIA
- Ministry of Environment, Forest and Climate Change (MoEFCC)
- Central Pollution Control Board (CPCB)
- United Nations Environment Programme (UNEP)
- United States Environmental Protection Agency (EPA)

- SWAYAM Online Courses
- World Bank Environmental Assessment Sourcebook
- Elsevier – Environmental Impact Assessment Review Journal

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Program:	**First Year M. Tech. (Civil Engineering)**						**Semester: II**	
Course:	**Sustainable Infrastructure & Management System**						**Code: T25BEI555**	
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**				
	Lecture	**Practical**	**Tutorial**	**Continuous Assessment**			**ESE**	**Total**
				TT1	**TT2**	**Internal Assessment**		
03	**03**	**-**	**-**	**20**	**20**	**40**	**60**	**100**

Course Objectives:

- To understand the concepts of sustainability and life-cycle thinking in infrastructure development.
- To study various tools and frameworks used for infrastructure planning and asset management.
- To learn sustainable practices in transportation, energy, water, and building systems.
- To develop analytical and decision-making skills for infrastructure sustainability assessment.

Course Outcomes:

After completing the course, students will be able to:

- To understand the concepts of sustainability and life-cycle thinking in infrastructure development.
- To study various tools and frameworks for infrastructure planning and asset management.
- To learn sustainable practices in transportation, energy, water, and building systems.
- To develop analytical and decision-making skills for infrastructure sustainability assessment

Detailed Syllabus

Unit	**Description**	**Duration (Hrs.)**	**BL**	**CO**
I	Introduction to Sustainable Infrastructure: Concepts of sustainability in civil engineering; Global sustainable development goals (SDGs); Triple bottom line (social, environmental, economic); Sustainability indicators; Infrastructure lifecycle stages.	8	L2	CO1
II	Sustainable Design and Construction Practices: Green building materials and methods; Energy-efficient systems; LEED, IGBC, and GRIHA rating	8	L2	CO1

	systems; Environmental impact assessment (EIA); Circular economy in construction; Construction waste minimization.			
III	Sustainable Transportation and Urban Systems: Non-motorized transport, public transport systems; Transit-oriented development (TOD); Low-carbon mobility; Smart cities; Green logistics; Urban heat island effect and mitigation.	8	L3	CO2
IV	Infrastructure Asset Management Systems (IAMS): Asset lifecycle and performance management; Pavement, bridge, and utility asset management systems; Preventive maintenance; Multi-criteria decision-making; Risk-based and value-based management frameworks.	8	L2	CO3
V	Policy, Finance, and Technology for Sustainability: Public-private partnerships (PPP); Carbon trading, green financing, and sustainability-linked bonds; Role of AI, IoT, and BIM in sustainable infrastructure; Case studies on smart water, energy grids, and resilient infrastructure systems.	7	L3	CO4
Total		**39**		

Text Books

- John W. Sutherland, David A. Dornfeld, Barbara Hauschild – Sustainability in Manufacturing
- Gibson, R. B. – Sustainability Assessment: Criteria and Processes, Earthscan
- Calkins, M. – Materials for Sustainable Sites: A Complete Guide to the Evaluation, Selection, and Use of Sustainable Construction Materials

Reference Books:

- IRC Guidelines for Sustainable Road Design
- UNEP Reports on Infrastructure and Sustainability
- Envision Sustainable Infrastructure Rating System Manual, ISI
- IS 15916: 2010 – Sustainability Guidelines for Buildings
- LEED and IGBC Manuals

Digital Resources:

- NPTEL Course: Sustainable Materials and Green Building
- USGBC, IGBC, GRIHA official portals

Envision: https://sustainableinfrastructure.org

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Program:	**First Year M. Tech. (Civil Engineering)**	**Semester: II**
Course:	**Prototyping and Product Development)**	**Code: T25BPP556**

Credit	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks		
	Lecture	Practical	Tutorial	TW	PR & OR	Total
02	-	02	-	50	50	100

Course Objectives:

This course aims at enabling students:

- To enable students to identify real-world civil engineering problems using structured innovation frameworks.
- To develop skills in creative thinking, ideation, and concept evaluation using design thinking tools.
- To provide hands-on experience in physical and digital prototyping techniques.
- To train students in iterative design, testing, and user feedback integration.
- To introduce intellectual property, MVP development, and commercialization strategies.

Course Outcomes:

After learning the course, the students will be able to:

CO1: Identify and define real-world civil engineering problems using innovation frameworks.
CO2: Generate and evaluate creative ideas using structured ideation tools.
CO3: Design and develop physical or digital prototypes for selected solutions.
CO4: Test prototypes, gather feedback, and improve product design iteratively.
CO5: Demonstrate understanding of intellectual property, MVP validation, and early-stage commercialization.

Guidelines for Students:

The laboratory practical is to be submitted by students in the form of a journal.

- Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each practical.
- Each assignment write-up should have Title, Objectives, out comes, Theory- Concept in brief, and Conclusion.

Guidelines for Laboratory/Term Work Assessment:

- Continuous assessment of laboratory work is based on overall performance and Laboratory practical performance of student.
- Each Laboratory practical assessment will assign grade/marks based on parameters with appropriate weightage.
- Suggested parameters for overall assessment as well as each Laboratory practical assessment include- timely completion, performance, innovation, efficient codes, punctuality, and neatness**.**

Guidelines for Laboratory Conduction

- Understand the Theory Behind the Experiment.
- Ensure Proper Setup and Calibration of Equipment.
- Follow Safety Protocols and Best Practices
- Collect data systematically, ensuring accuracy in measurements.

Record all observations and results promptly and clearly in the lab notebook.

Detailed Syllabus

Experiment No.	Practical	BL	CO
SECTION A: Introduction to Innovation & Problem Identification			
1.	Identify and validate real-life civil engineering problems (transport, waste, water, structures). • Tool: Problem-Solution Fit Canvas Output: Problem Statement + Stakeholder Mapping	L3	CO1
2.	Use Design Thinking – Empathize, Define, Ideate	L3	CO1

	• Conduct interviews, observations, and map user journey Output: Empathy Map, Need Statement, HMW (How Might We?) Questions		
SECTION B: Ideation Techniques & Conceptualization			
3.	Mind Mapping and SCAMPER techniques for idea generation • Domain Examples: Smart pavements, debris detection, stormwater reuse Output: Ideation Sheet with 5–10 conceptual ideas	L4	CO2
4.	Idea shortlisting using Feasibility-Impact matrix Output: One selected concept with justification	L4	CO2
SECTION C: Prototyping Skills			
5.	Low-Fidelity Prototyping • Tools: Paper sketches, cardboards, mock-ups • Example: Cross-section of a smart road, green roof models Output: Physical model with annotations	L5	CO3
6.	Digital Prototyping using tools like AutoCAD/Fusion 360/TinkerCAD • Domain: Smart street design, traffic-calming devices Output: 2D/3D renderings of selected solution	L5	CO3
SECTION D: Minimum Viable Product (MVP) Development			
7.	MVP planning – define core functionality Format: Business Model Canvas and MVP feature list	L5	CO3
8.	Build a working MVP prototype • Tool options: IoT components, Arduino, QGIS-based dashboards • Examples: o Smart bin fill-level detector o GIS-based flood alert model o Modular water purifier prototype Output: Video demo + working prototype	L5	CO3
SECTION E: Testing, Feedback & Iteration			
9.	User testing and feedback collection • Tools: Google Forms, A/B testing, stakeholder interviews Output: Feedback sheet, iteration plan	L5	CO4
10.	Prototype refinement based on user input Output: V2 of the prototype + modifications log	L5	CO4
SECTION F: Intellectual Property and Commercialization			
11.	Patent search and prior art study (IPIndia, WIPO, Google Patents) Output: Novelty check report	L5	CO5
12.	Drafting a patent abstract and claim set for the project	L5	CO5

	Optional: Filing via KAPILA portal (if eligible)		
13.	Prepare a Go-to-Market Strategy Output: Pitch deck (Problem, Solution, Impact, Scalability, IP, Revenue model)	L5	CO5
SECTION G: Final Demo and Review			
14.	Showcase working prototype with posters/presentation • Jury: Faculty + external expert panel (mentor from IIC/industry) • Output: Prototype + Poster + Pitch Presentation	L5	CO5
	Text Books: • Showcase working prototype with posters/presentation • Jury: Faculty + external expert panel (mentor from IIC/industry) Output: Prototype + Poster + Pitch Presentation		
	Reference Books: 1. Ries E., 2011, "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses", 1st Edition, Crown Business, New York. 2. Drucker P. F., 2006, "Innovation and Entrepreneurship: Practice and Principles", Reprint Edition, HarperBusiness, New York. 3. Kelley T. and Littman J., 2001, "The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm", 1st Edition, Currency (Random House), New York. Adelman M. D., Rader K. L., and Engel R. D., 2013, "Patent Law for Engineers and Scientists", 3rd Edition, Cengage Learning, Boston.		
	Digital Content: NPTEL / SWAYAM 1. Design Thinking - A Primer by Prof. Ashwin Mahalingam (IIT Madras) 2. Product Design and Manufacturing by Prof. Anupam Saxena (IIT Kanpur) 3. Innovation by Design – IIT Roorkee (Upcoming/Archived) Coursera 1. Design Thinking for Innovation – University of Virginia 2. Digital Prototyping – University of Maryland 3. Creative Problem Solving – University of Minnesota edX 1. Product Management with Lean, Agile and System Design Thinking – Boston University 2. Introduction to Intellectual Property – WIPO Academy Virtual Labs / Platforms 1. FOSSEE (IIT Bombay) Product Design Virtual Lab 2. TinkerCAD (Autodesk) – Online 3D Design and Simulation 3. MIT App Inventor – For prototyping mobile-based solutions IPIndia Portal – Search and Filing of Indian Patents		
	Tools & Software Suggested • **Design & Sketching**: Canva, Draw.io, Figma, AutoCAD, Fusion360 • **Prototyping Hardware**: Arduino, Raspberry Pi, basic sensors • **GIS**: QGIS, ArcGIS • **IPR**: ipindia.gov.in, WIPO Patent Search **Startup & Pitching**: BMC (Strategyzer), Slidebean, Canva for pitch decks		

	Term Work: 1. An IP (Copyright, Design Application or Patent Filed) for the product/Idea. Certificate of presentation of idea/product in atleast one National/International Platform entrepreneurship/Idea/Innovation Competition.

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Program:	**First Year M. Tech. (Common to all branches)**			**Semester: II**		
Course:	**FutureTech in Civil Engineering: AI, IoT & Digital Solutions**			**Code: T25BFT557**		
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**		
	Lecture	**Practical**	**Tutorial**	**TW**	**PR & OR**	**Total**
01	**-**	**02**	**-**	**50**	**--**	**50**

Course Outcomes:

After learning the course, the students will be able to:

- Understand the role of AI and Big Data in revolutionizing modern civil engineering practices.
- Apply machine learning techniques for solving real-world civil engineering problems such as traffic forecasting, structural health monitoring, and resource optimization.
- Analyze case studies involving digital twins, smart cities, and predictive maintenance.
- Design and implement data-driven mini-projects using Python, MATLAB, or relevant tools.
- Collaborate and present innovative solutions integrating digital transformation into civil infrastructure projects.

Guidelines for Students:

The laboratory practical is to be submitted by students in the form of a journal.

- Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each practical.
- Each assignment write-up should have Title, Objectives, out comes, Theory- Concept in brief, and Conclusion.

Guidelines for Laboratory/Term Work Assessment:

- Continuous assessment of laboratory work is based on overall performance and Laboratory practical performance of student.
- Each Laboratory practical assessment will assign grade/marks based on parameters with appropriate weightage.
- Suggested parameters for overall assessment as well as each Laboratory practical assessment include- timely completion, performance, innovation, efficient codes, punctuality, and neatness**.**

Guidelines for Laboratory Conduction

- Understand the Theory Behind the Experiment.
- Ensure Proper Setup and Calibration of Equipment.
- Follow Safety Protocols and Best Practices
- Collect data systematically, ensuring accuracy in measurements.
- Record all observations and results promptly and clearly in the lab notebook.

Detailed Syllabus

	Experiment Title
1	Introduction to Digital Transformation in Civil Engineering
2	Basics of AI and Machine Learning in Engineering Applications

3	Big Data Analytics and Visualization in Infrastructure Systems
4	IoT, Digital Twins, and Smart Cities
5	Case Studies: AI in Transportation, Water Resources, and Construction
6	Experiential Sessions: Tools (Python, MATLAB, Power BI, etc.)
7	Capstone Mini-Project: Domain-specific problem using AI/Big Data

References:

Recommended Books

1. **"Artificial Intelligence and Machine Learning for Civil Engineers"**

Author: Shahab D. Mohaghegh
Publisher: Gulf Publishing
Focus: Application of AI/ML in civil and geotechnical engineering.

2. **"Data Science for Engineers"**

Author: R. Nagendran
Publisher: Wiley
Focus: Fundamentals of data handling, processing, and analytics, tailored for engineering problems.

3. **"Big Data: Principles and Paradigms"**

Editors: Rajkumar Buyya, Rodrigo N. Calheiros, Amir Vahid Dastjerdi
Publisher: Morgan Kaufmann
Focus: Core concepts of Big Data and cloud-based data processing.

4. **"Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia"**

Author: Anthony M. Townsend
Publisher: W. W. Norton & Company
Focus: Urban digital transformation and smart infrastructure.

5. **"Machine Learning for Civil and Environmental Engineers"**

Author: Bruno Lopes
Publisher: Springer
Focus: ML methods applied to hydrology, structural engineering, and transportation.

6. **"Introduction to Smart Cities"**

Author: Leonidas Anthopoulos
Publisher: CRC Press
Focus: Framework and technologies behind smart infrastructure planning.

Online Learning

1. **Coursera**
   - AI for Everyone – Andrew Ng (Stanford University)
   - Big Data Specialization – University of California San Diego
   - Smart Cities – Management of Smart Urban Infrastructures – EPFL
2. **edX**
   - Data Science and Machine Learning Essentials – Microsoft
   - Digital Transformation in Infrastructure – Delft University of Technology
3. **NPTEL / SWAYAM**
   - Data Science for Engineers – IIT Madras
   - Artificial Intelligence for Civil Engineering Applications – IIT Kharagpur
   - Smart Cities – IIT Roorkee

Software Tutorials and Tools

- Python for Data Science**:** **https://www.learnpython.org**
- MATLAB Machine Learning Onramp**: https://matlabacademy.mathworks.com**
- Power BI Guided Learning**:** **https://learn.microsoft.com/en-us/power-bi/**

- Kaggle Datasets and Tutorials**:** **https://www.kaggle.com**

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CURRICULUM STRUCTURE

Second Year M. Tech. (Civil Engineering) Semester – III

Program:	**Second Year M. Tech. (Civil Engineering)**			**Semester: III**		
Course:	**Next-Gen Civil Engineering: AI, Big Data & Digital Transformation (NGCE-ABDT)**			**Code: T25BNCE601**		
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**		
	Lecture	**Practical**	**Tutorial**	**TW**	**PR & OR**	**Total**
01	**-**	**04**	**-**	**50**	**50**	**100**

Course Outcomes:

After learning the course, the students will be able to:

- Understand the role of AI and Big Data in revolutionizing modern civil engineering practices.
- Apply machine learning techniques for solving real-world civil engineering problems such as traffic forecasting, structural health monitoring, and resource optimization.
- Analyze case studies involving digital twins, smart cities, and predictive maintenance.
- Design and implement data-driven mini-projects using Python, MATLAB, or relevant tools.
- Collaborate and present innovative solutions integrating digital transformation into civil infrastructure projects.

Guidelines for Students:

The laboratory practical is to be submitted by students in the form of a journal.

- Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each practical.
- Each assignment write-up should have Title, Objectives, out comes, Theory- Concept in brief, and Conclusion.

Guidelines for Laboratory/Term Work Assessment:

- Continuous assessment of laboratory work is based on overall performance and Laboratory practical performance of student.
- Each Laboratory practical assessment will assign grade/marks based on parameters with appropriate weightage.
- Suggested parameters for overall assessment as well as each Laboratory practical assessment include- timely completion, performance, innovation, efficient codes, punctuality, and neatness**.**

Guidelines for Laboratory Conduction

- Understand the Theory Behind the Experiment.
- Ensure Proper Setup and Calibration of Equipment.
- Follow Safety Protocols and Best Practices
- Collect data systematically, ensuring accuracy in measurements.
- Record all observations and results promptly and clearly in the lab notebook.

Detailed Syllabus	
Sr. No.	**Topics to be Referred**

1	Introduction to Digital Transformation in Civil Engineering
2	Basics of AI and Machine Learning in Engineering Applications
3	Big Data Analytics and Visualization in Infrastructure Systems
4	IoT, Digital Twins, and Smart Cities
5	Case Studies: AI in Transportation, Water Resources, and Construction
6	Experiential Sessions: Tools (Python, MATLAB, Power BI, etc.)
7	Capstone Mini-Project: Domain-specific problem using AI/Big Data

References:

Recommended Books

1. "Artificial Intelligence and Machine Learning for Civil Engineers"
Author: Shahab D. Mohaghegh
Publisher: Gulf Publishing
Focus: Application of AI/ML in civil and geotechnical engineering.
2. "Data Science for Engineers"
Author: R. Nagendran
Publisher: Wiley
Focus: Fundamentals of data handling, processing, and analytics, tailored for engineering problems.
3. "Big Data: Principles and Paradigms"
Editors: Rajkumar Buyya, Rodrigo N. Calheiros, Amir Vahid Dastjerdi
Publisher: Morgan Kaufmann
Focus: Core concepts of Big Data and cloud-based data processing.
4. "Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia"
Author: Anthony M. Townsend
Publisher: W. W. Norton & Company
Focus: Urban digital transformation and smart infrastructure.
5. "Machine Learning for Civil and Environmental Engineers"
Author: Bruno Lopes
Publisher: Springer
Focus: ML methods applied to hydrology, structural engineering, and transportation.
6. "Introduction to Smart Cities"
Author: Leonidas Anthopoulos
Publisher: CRC Press
Focus: Framework and technologies behind smart infrastructure planning.

Online Learning

1. Coursera
AI for Everyone – Andrew Ng (Stanford University)
Big Data Specialization – University of California San Diego
Smart Cities – Management of Smart Urban Infrastructures – EPFL
2. edX
Data Science and Machine Learning Essentials – Microsoft
Digital Transformation in Infrastructure – Delft University of Technology
3. NPTEL / SWAYAM
Data Science for Engineers – IIT Madras
Artificial Intelligence for Civil Engineering Applications – IIT Kharagpur
Smart Cities – IIT Roorkee

Software Tutorials and Tools

- Python for Data Science: https://www.learnpython.org

- MATLAB Machine Learning Onramp: https://matlabacademy.mathworks.com
- Power BI Guided Learning: https://learn.microsoft.com/en-us/power-bi/
- Kaggle Datasets and Tutorials: https://www.kaggle.com

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Program:	**Second Year M. Tech. (Civil Engineering)**				**Semester: III**	
Course:	**Research Paper Publication -I**				**Code: T25BRP1602**	
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**		
	Lecture	**Practical**	**Tutorial**	**TW**	**PR & OR**	**Total**
01	**-**	**04**	**-**	**50**	**50**	**100**

Course Outcomes:

After learning the course, the students will be able to:

CO1: Scholars will be able to explain the structure and key elements of a research paper.

CO2: Scholars will be able to critically review literature and identify research gaps.

CO3: Scholars will demonstrate the ability to write and organize a research paper ethically.

CO4: Scholars will use citation tools and plagiarism checkers effectively.

CO5: Scholars will be able to prepare and submit a research paper to appropriate journals or erences.

Guidelines for Students:

The laboratory practical is to be submitted by students in the form of a journal.

- Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each tical.
- Each assignment write-up should have Title, Objectives, out comes, Theory- Concept in brief, and clusion.

Guidelines for Laboratory/Term Work Assessment:

- Continuous assessment of laboratory work is based on overall performance and Laboratory practical ormance of student.
- Each Laboratory practical assessment will assign grade/marks based on parameters with appropriate ghtage.
- Suggested parameters for overall assessment as well as each Laboratory practical assessment ude- timely completion, performance, innovation, efficient codes, punctuality, and neatness**.**

Guidelines for Laboratory Conduction

- Understand the Theory Behind the Experiment.
- Ensure Proper Setup and Calibration of Equipment.
- Follow Safety Protocols and Best Practices
- Collect data systematically, ensuring accuracy in measurements.
- Record all observations and results promptly and clearly in the lab notebook.

Detailed Syllabus

Sr. No.	**Topics Covered**
1	What is research writing? Why is it important? Types of research papers.
2	How to read and review scientific papers. Where to find quality sources.
3	How to find a research gap and form a clear research objective.

4	Breaking down a paper: title, abstract, introduction, and more.
5	Writing methods, results, and discussion sections effectively.
6	Understanding plagiarism, ethics, and fair publishing practices.
7	Referencing made easy: tools like Mendeley/Zotero and proper citation styles.
8	How to choose the right journal: what is impact factor, indexing, UGC CARE, etc.
9	Using Grammarly and formatting tools (Word/LaTeX). Writing clearly and professionally.
10	How peer review works and how to respond to reviewers' comments.
11	Final checklist before submission. Step-by-step submission process.
12	Finalize your paper. Share, review, and get feedback from classmates and mentor.

References:

Recommended Books

- "Research Methodology: Methods and Techniques" by C.R. Kothari
  - A comprehensive guide covering all aspects of research design, methodology, and writing.
- "How to Write and Publish a Scientific Paper" by Robert A. Day and Barbara Gastel
  - Practical advice on writing, structuring, and publishing research papers.
- "Publication Manual of the American Psychological Association (APA)"
  - Essential for understanding citation, referencing, and ethical publication standards.
- "Writing Research Papers: A Complete Guide" by James D. Lester and James D. Lester Jr.
  - Step-by-step guidance for developing, writing, and submitting research manuscripts.
- "The Craft of Research" by Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams
  - Insightful resource on formulating research questions and communicating research effectively.

Online Learning

- **Research Methodology – IIT Madras**
  - **Instructor**: Prof. Edamana Prasad & Prof. Prathap Haridoss
  - **Duration**: 8 weeks
  - **Overview**: This course introduces students to the essential aspects of research, aiming to make n aware of the details associated with formal research and to help overcome common misconceptions.
- **Research Methodology – IISER Kolkata**
  - **Instructor**: Prof. Soumitro Banerjee
  - **Duration**: 12 weeks
  - **Overview**: Covers conceptual and methodological issues in research, including philosophy of nce, measurement, hypothesis testing, scientific communication, and ethical issues.
- **Qualitative Research Methods and Research Writing – IIT Kharagpur**
  - **Instructor**: Prof. Aradhna Malik
  - **Duration**: 12 weeks
  - **Overview**: Introduces students to qualitative research, helping them understand how it lements quantitative inquiry in human behavior and social sciences.

Academic Writing Courses

1. **NOC: Research Writing – IIT Kharagpur**
   - **Instructor**: Prof. Aradhna Malik

- **Duration**: 4 weeks
- **Overview**: Focuses on the nuances of effective writing, aiming to help students write with ty, precision, and subtlety to express their ideas.

2. **Effective Writing – IIT Madras**
   - **Instructor**: Prof. M. S. Sriram
   - **Duration**: 8 weeks
   - **Overview**: Aims to familiarize students with the nuances of effective writing, allowing n to write with clarity, precision, and subtlety.

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Program:	**Second Year M. Tech. (Civil Engineering)**				**Semester: III**	
Course:	**Dissertation Phase-I**				**Code: T25BDP1603**	
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**		
	Lecture	**Practical**	**Tutorial**	**TW**	**PR & OR**	**Total**
16	**-**	**32**	**-**	**200**	**300**	**500**

Course Outcomes:

After learning the course, the students will be able to:

CO1 Identify a relevant civil engineering problem through industry need analysis, societal relevance, or research gap study.

CO2 Conduct a thorough literature review and patent search to establish the research scope, novelty, and direction.

CO3 Formulate clear research objectives and methodology based on conceptual understanding and preliminary study.

CO4 Develop a structured research plan including experimentation/modelling tools and timelines.

CO5 Present the research proposal effectively through technical reports and oral presentations.

Guidelines for Students:

The laboratory practical is to be submitted by students in the form of a journal.

- Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each practical.
- Each assignment write-up should have Title, Objectives, out comes, Theory- Concept in brief, and Conclusion.

Guidelines for Laboratory/Term Work Assessment:

- Continuous assessment of laboratory work is based on overall performance and Laboratory practical performance of student.
- Each Laboratory practical assessment will assign grade/marks based on parameters with appropriate weightage.
- Suggested parameters for overall assessment as well as each Laboratory practical assessment include- timely completion, performance, innovation, efficient codes, punctuality, and neatness**.**

Guidelines for Laboratory Conduction

- Understand the Theory Behind the Experiment.
- Ensure Proper Setup and Calibration of Equipment.
- Follow Safety Protocols and Best Practices

- Collect data systematically, ensuring accuracy in measurements.
- Record all observations and results promptly and clearly in the lab notebook.

Detailed Syllabus

Sr. No.	Topics Covered
1	**Topic Identification**
2	- Problem Identification (preferably industry-sponsored) - Initial field/desk study - Faculty/mentor allocation
3	**Literature Review**
4	- Detailed review of journals, patents, standards, and practices - Problem statement and gap identification
5	**Proposal Development**
6	-Define objectives, scope, and expected outcomes - Conceptual methodology and initial system design
7	**Research Plan**
8	- Research/experimental setup/modeling tool selection - Prepare action plan with timelines and deliverables
9	**Pre-Research Presentation Series**
10	-**Presentation 1 (Week 4)**: Problem & Background - **Presentation 2 (Week 8)**: Literature & Methodology - **Presentation 3 (Week 12)**: Proposed work & pilot trials
11	**Final Presentation & Report**
12	-Dissertation Phase–I Report - Ready plan for Phase–II with finalized methodology, sample data/experiments

- **Faculty Guide**: Assigned at the start of Phase–I
- **Industry/Govt. Mentor (Preferred)**: If sponsored/associated

Institution's Innovation Council (IIC): Support for idea validation, patenting, and funding

Assessment and Evaluation Pattern

Component	Weightage
1. Periodic Reviews/Presentations (3)	30%
2. Final Presentation and Viva Voce	20%
3. Dissertation Report (Structure, Depth)	30%
Innovation/Research Output (Paper/IP)	20%

Term Work: Minimum 2 from section A and minimum 4 Practical from section B shall be submitted.

1. A certification course/training program as suggested by guide preferably NPTEL, Coursera or reputed institutes.
2. Submission of sponsored project proposal

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CURRICULUM STRUCTURE

Second Year M. Tech. (Civil Engineering) Semester – IV

Program:	**Second Year M. Tech. (Civil Engineering)**				**Semester: IV**	
Course:	**Research Paper Publication -II**				**Code: T25BRP2651**	
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**		
	Lecture	**Practical**	**Tutorial**	**TW**	**PR & OR**	**Total**
02	**-**	**04**	**-**	**50**	**50**	**100**

Course Outcomes:

After learning the course, the students will be able to:

CO1: Scholars will be able to revise and improve a complete research paper draft.
CO2: Scholars will effectively address reviewer comments and editorial feedback.
CO3: Scholars will apply advanced formatting, referencing, and citation guidelines.
CO4: Scholars will understand the submission workflows of reputed journals.
CO5: Scholars will be able to track citations, impact metrics, and maintain research visibility.

Guidelines for Students:

The laboratory practical is to be submitted by students in the form of a journal.

- Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each practical.
- Each assignment write-up should have Title, Objectives, out comes, Theory- Concept in brief, and Conclusion.

Guidelines for Laboratory/Term Work Assessment:

- Continuous assessment of laboratory work is based on overall performance and Laboratory practical performance of student.
- Each Laboratory practical assessment will assign grade/marks based on parameters with appropriate weightage.
- Suggested parameters for overall assessment as well as each Laboratory practical assessment include- timely completion, performance, innovation, efficient codes, punctuality, and neatness**.**

Guidelines for Laboratory Conduction

- Understand the Theory Behind the Experiment.
- Ensure Proper Setup and Calibration of Equipment.
- Follow Safety Protocols and Best Practices
- Collect data systematically, ensuring accuracy in measurements.
- Record all observations and results promptly and clearly in the lab notebook.

Detailed Syllabus

Sr. No.	**Topics Covered**
1	Recap of research paper structure and reviewing feedback from Part I.
2	Identifying and addressing gaps in content, logic, and argument.
3	Improving clarity, cohesion, and presentation of research findings.
4	Deep dive into referencing: updating sources, managing citations.
5	Plagiarism check, self-review checklist, and grammar tools.

6	Journal selection: matching scope, indexing (Scopus, SCI, UGC CARE), and impact factor.
7	Submission procedures: cover letters, declarations, copyright forms.
8	Understanding the peer review process and typical reviewer comments.
9	Strategies for revising manuscripts based on reviewer/editor input.
10	Tools for altmetrics, impact tracking, and citation management.
11	Pre-publication and post-publication ethics and visibility tips.
12	Final submission of revised paper; feedback from mentors/peers.

References:

Recommended Books

- How to Write and Publish a Scientific Paper by Robert A. Day and Barbara Gastel, A practical guide to scientific communication and manuscript refinement.
- The Craft of Scientific Writing by Michael Alley, Advanced guidance on clarity, logic, and structure in scientific communication.
- Scientific Writing and Communication: Papers, Proposals, and Presentations by Angelika H. Hofmann, Detailed techniques for writing and improving scholarly publications.
- Manual for Writers of Research Papers, Theses, and Dissertations by Kate L. Turabian A trusted manual for formatting, revising, and preparing academic research work.
- Publication Manual of the APA (Latest Edition), Essential reference for formatting, referencing, and ethical compliance.

Research Methodology Courses

- Writing and Publishing Scientific Research Papers – IIT Madras
- Effective Writing – IIT Madras
- Research Methodology – IIT Kharagpur or IISER Kolkata
- Intellectual Property Rights and Ethics – IIT Roorkee
- Qualitative Research Methods and Research Writing – IIT Kharagpur

Prepared by **Verified by** **M. Tech. Coordinator** **HOD** **Dean**

Program:	**Second Year M. Tech. (Civil Engineering)**			**Semester: IV**		
Course:	**Dissertation Phase-II**			**Code: T25BDP2652**		
Credit	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**		
	Lecture	**Practical**	**Tutorial**	**TW**	**PR & OR**	**Total**
18	**-**	**36**	**-**	**300**	**300**	**600**

Course Outcomes:

After learning the course, the students will be able to:

CO1 Identify a relevant civil engineering problem through industry need analysis, societal relevance, or research gap study.

CO2 Conduct a thorough literature review and patent search to establish the research scope, novelty, and direction.
CO3 Formulate clear research objectives and methodology based on conceptual understanding and preliminary study.
CO4 Develop a structured research plan including experimentation/modelling tools and timelines.
CO5 Present the research proposal effectively through technical reports and oral presentations.

Guidelines for Students:

The laboratory practical is to be submitted by students in the form of a journal.

- Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each practical.
- Each assignment write-up should have Title, Objectives, out comes, Theory- Concept in brief, and Conclusion.

Guidelines for Laboratory/Term Work Assessment:

- Continuous assessment of laboratory work is based on overall performance and Laboratory practical performance of student.
- Each Laboratory practical assessment will assign grade/marks based on parameters with appropriate weightage.
- Suggested parameters for overall assessment as well as each Laboratory practical assessment include- timely completion, performance, innovation, efficient codes, punctuality, and neatness**.**

Guidelines for Laboratory Conduction

- Understand the Theory Behind the Experiment.
- Ensure Proper Setup and Calibration of Equipment.
- Follow Safety Protocols and Best Practices
- Collect data systematically, ensuring accuracy in measurements.
- Record all observations and results promptly and clearly in the lab notebook.

Detailed Syllabus

Sr. No.	Topics Covered
1	**Experimentation/Modelling**
2	- Execute methodology through experimentation, simulation, or analytical modeling
3	**Data Analysis**
4	- Process and analyze data - Draw inferences aligned with objectives
5	**Technical Communication**
6	- Prepare manuscript for conference/journal - Draft patent/IP application - Draft funding proposal
7	**Industry/Govt. Collaboration**
8	- Industry interaction/report submission - Draft proposal for scale-up, testing or funding
9	**Presentation Series**
10	- **Presentation 1 (Week 4)**: Experimental setup/modeling progress - **Presentation 2 (Week 8)**: Data/results + draft publication - **Presentation 3 (Week 12)**: Final analysis and outcomes
11	**Final Presentation & Submission**
12	- Viva Voce

	- Final Report - Proof of submission: paper, patent, or proposal to industry/government body
	Mentorship and Collaboration • **Faculty Guide:** Assigned at the start of Phase–I • **Industry/Govt. Mentor (Preferred):** If sponsored/associated • **Institution's Innovation Council (IIC):** Support for idea validation, patenting, and funding • **External Examiner:** For Phase–II viva and evaluation **Documentation Guidelines** • Dissertation report as per standard institute format (includes abstract, objectives, literature review, methodology, results, conclusion, references) • Paper/patent manuscript appended in the annexure Logbook/Project diary to be maintained and verified by guide
	Assessment and Evaluation Pattern **Component** **Weightage** 1. Periodic Reviews/Presentations (3) 30% 2. Final Presentation and Viva Voce 20% 3. Dissertation Report (Structure, Depth) 30% Innovation/Research Output (Paper/IP) 20%
	Term Work: 1. A conference publication with scopus indexed proceeding. 2. A research paper submitted to scopus indexed journal. 3. Idea presentation in suitable platform and pilot product. **Expected Outcomes** **Area** **Expected Result** **Technical Output** Project model, algorithm, simulation, design proposal, prototype **Scientific Output** Submission/presentation of a conference/journal paper (Scopus/Web of Science preferred) **Innovation/IP** Patent filing, design registration, innovation disclosure **Societal Impact** Real-world implementation or impact proposal (to industry/municipality/govt. agency) **Funding Ready** Draft funding proposal (DST, SERB, AICTE, DBT, MoHUA, Jal Shakti, etc.)

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