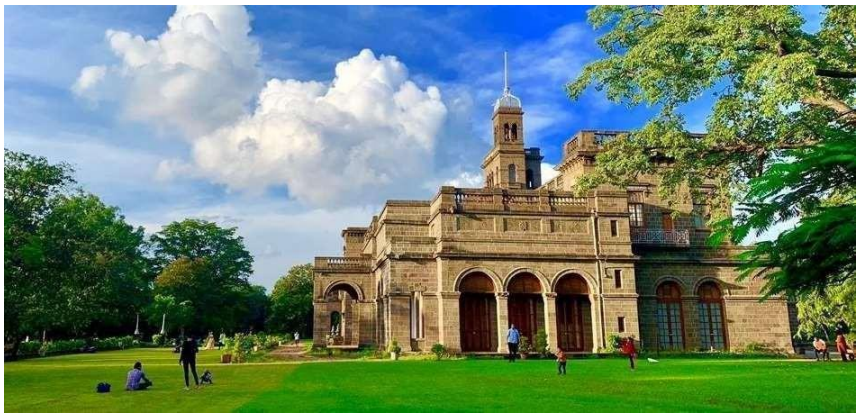
सावित्रीबाई फुले पुणे विद्यापीठ

Savitribai Phule Pune University, Pune, Maharashtra, India

Faculty of Science and Technology



National Education Policy (NEP)-2020

Compliant Curriculum for

Third Year Engineering (2024 Pattern)

Civil Engineering

(With effect from Academic Year 2026-27)

CONTENTS

Nomenclature

AEC Ability Enhancement Course

AICTE All India Council for Technical Education

CEP Community Engagement Project

EEM Entrepreneurship / Economics/ Management

MDM Multidisciplinary Minor

MOOC Massive Open Online Course

NEP National Educational Policy

NPTEL National Programme on Technology Enhanced Learning

OE Open Elective

PCC Program Core Course

PO'S Program Outcomes

PEO'S Programme Educational Objectives

PSO'S Program Specific Outcomes

SWAYAM Study Webs of Active-Learning for Young Aspiring Minds\\

VEC Value Education Course

VSE Vocational and Skill Enhancement Course

WK Knowledge and Attitude Profile

FP Field Project

Preface by Board of Studies

Dear Students and Faculty Members,

We, the members of Board of Studies Civil Engineering, are very happy to present the Third Year Civil Engineering syllabus effective from the Academic Year 2026-27. The present curriculum will be implemented for the Third Year of Civil Engineering course from Academic Year 2026-27.

Civil Engineering is a dynamic discipline that lies at the intersection of engineering, design and environmental stewardship. It provides the foundation for the planning, design, construction and maintenance of infrastructure systems that support modern society. While designing this curriculum, due consideration has been given to the guidelines of regulatory bodies, industry requirements, recent technological advancements, and feedback received from academicians, industry experts, alumni, and other stakeholders. The syllabus aims to bridge the gap between academic knowledge and professional practice, thereby enhancing the employability, innovation, and lifelong learning capabilities of students.

The revised syllabus falls in line with the objectives of NEP-2020, Savitribai Phule Pune University (SPPU), AICTE New Delhi, UGC and various accreditation agencies by keeping an eye on the technological developments, innovations and industry requirements. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

We sincerely appreciate the valuable contributions and suggestions received from subject experts, faculty members, industry representatives, alumni, and all stakeholders during the curriculum revision process. We are confident that the revised syllabus will contribute significantly to the academic and professional growth of students and will assist faculty members in delivering quality technical education.

We extend our best wishes to all students and faculty members for the successful implementation of this Third Year Civil Engineering syllabus.

Dr. Sunil B. Thakare
Chairman
Board of Studies, SPPU, Pune

Members, Board of Studies-Civil Engineering	
Dr. Ganesh A. Hinge	Dr. Pratibha M. Alandkar
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Curriculum for Third Year - Civil Engineering (2024 Pattern)

Program Specific Outcomes (PSO's)

PSO 1: Application of Core Civil Engineering Principles

Graduates will be able to apply fundamental concepts of structural analysis, geotechnical engineering, transportation systems, water resources engineering, and environmental engineering to design and develop sustainable and efficient civil infrastructure.

PSO 2: Proficiency in Modern Tools and Techniques

Graduates will be proficient in using modern tools & Software's for planning, analysis, design, and execution of Civil Engineering projects in compliance with safety, environmental, and ethical standards.

PSO 3: Problem Solving and Project Execution Skills

Graduates will demonstrate the ability to identify, analyze, and solve real-world Civil Engineering problems and effectively manage construction projects, incorporating principles of design thinking, innovations, and lifelong learning.

Program Educational Objectives (PEO's)

Program Educational Objectives (PEOs): Program Educational Objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.

PEO1: Core Competency and Professional Excellence

Graduates will establish themselves as successful Civil Engineering professionals by applying their technical knowledge, problem-solving abilities, and ethical values in planning, designing, and executing infrastructure projects that meet societal needs.

PEO2: Higher Education and Lifelong Learning

Graduates will pursue advanced education, research, or professional development to stay current with emerging trends, technologies, and practices in Civil Engineering and related interdisciplinary fields.

PEO3: Leadership and Social Responsibility

Graduates will demonstrate leadership, teamwork, effective communication, and a commitment to sustainable development by engaging in projects that contribute to environmental conservation and the betterment of society.

Curriculum for Third Year - Civil Engineering (2024 Pattern)
Knowledge and Attitude Profile (WK)

A Knowledge and Attitude Profile (KAP), often represented as WK (Knowledge and Attitude Profile) in some contexts, is a framework or assessment tool used to evaluate an individual's knowledge and attitudes related to a specific area, topic, or domain.

WK1	A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
WK2	Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
WK3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
WK4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
WK5	Knowledge, including efficient resource use, environmental impacts, Whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
WK6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
WK7	Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
WK8	Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
WK9	Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

Reference: Self-Assessment Report (SAR) Format Undergraduate Engineering Programs Graduate Attributes and Professional Competencies Version 4.0 (GAPCV4.0) - (August 2024) Page 55.

Curriculum for Third Year - Civil Engineering (2024 Pattern)
Program Outcomes (PO's)

Program Outcomes are statements that describe what students are expected to know and be able to do upon graduating from the program. These relate to the skills, knowledge, attitude and behavior that students acquire through the program. On successful completion of Civil Engineering, graduating students/graduates will be able to:

PO1	Engineering knowledge	Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop the solution of complex engineering problems.
PO2	Problem analysis	Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
PO3	Design / Development of Solutions	Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
PO4	Conduct Investigations of Complex Problems	Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
PO5	Engineering Tool Usage	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
PO6	The Engineer and The World	Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
PO7	Ethics	Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO8	Individual and Collaborative Teamwork	Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9	Communication	Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
PO10	Project Management and Finance	Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	Life-Long Learning	Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Reference: Self-Assessment Report (SAR) Format Undergraduate Engineering Programs Graduate Attributes and Professional Competencies Version 4.0 (GAPC V4.0) - (August 2024) Page 56.

General Rules and Guidelines

Course Outcomes (CO): Course Outcomes are narrower statements that describe what students are expected to know and are able to do at the end of each course. These relate to the skills, knowledge and behavior that students acquire in their progress through the course.

Assessment: Assessment is one or more processes, carried out by the institution, that identify, collect and prepare data to evaluate the achievement of Program Educational Objectives and Program Outcomes.

Evaluation: Evaluation is one or more processes, done by the Evaluation Team, for interpreting the data and evidence accumulated through assessment practices. Evaluation determines the extent to which Program Educational Objectives or Program Outcomes are being achieved, and results in decisions and actions to improve the program

Guidelines for Examination Scheme

Examination:

The examination consists of two parts, Comprehensive Continuous Evaluation (CCE) and End-Semester Examination (ESE).

Part I: Comprehensive Continuous Evaluation (CCE)

a. Comprehensive Continuous Evaluation (CCE) of 30 marks based on all units of course, to be scheduled & conducted at institute level. Comprehensive Continuous Evaluation (CCE) consists of parameters & weightage as mentioned below:

Sr. No	Parameters	Marks	Based on	Marking Scheme
1	Unit Test	12 Marks	Units 1 & Unit 2	6 Marks per Unit
2	Assignments / Case Study	12 Marks	Units 3 & Unit 4	6 Marks per Unit
3	Seminar Presentation /Open Book Test/Quiz	06 Marks	Unit 5	6 Marks per Unit

b. CCE of 15 marks based on all the Units of course syllabus to be scheduled and conducted at institute level. To design a CCE scheme for a theory subject of 15 marks with the specified parameters, the allocation of marks and the structure can be detailed as follows:

Sr.	Parameters	Marks	Coverage of Units
1	Unit Test	10 Marks	Units 1 & Unit 2 (5 Marks/Unit)
2	Seminar Presentation / Open Book Test/ Assignments/Case Studies	05 Marks	Units 3 & Unit 4

1. Unit Test

Unit Test	**Format:** Questions to be designed as per Bloom's Taxonomy guidelines to assess various cognitive levels (Remember, Understand, Apply, Analyze, Evaluate, Create).
	Implementation: Schedule the test after completing Units 1 and 2. Ensure the question paper is balanced and covers key concepts and applications.
	Evaluation and Feedback: Evaluate promptly and provide constructive feedback on strengths and areas for improvement.

	Sample Question Distribution **Remembering (2 Marks):** Define key terms related to [Topic from Units 1 and 2]. **Understanding (2 Marks):** Explain the principle of [Concept] in [Context]. **Applying (2 Marks):** Demonstrate how [Concept] can be used in [Scenario]. **Analyzing (3 Marks):** Compare & contrast [Two related concepts] from Units 1 and 2. **Evaluating (3 Marks):** Evaluate the effectiveness of [Theory / Model] in [Situation].

2. Assignments / Case Study

Assignments / Case Study	**Format:** Problem-solving tasks, theoretical questions, practical exercises, or case studies that require in-depth analysis and application of concepts.
	Implementation: Distribute the assignments or case study after covering Units 3 & 4.
	Provide clear guidelines and a rubric for evaluation.
	Evaluation and Feedback: Assess the quality of submissions based on the provided rubric. Offer feedback to help students understand their performance.

3. Seminar Presentation /Open Book Test/Quiz

Seminar Presentation	**Format:** Presentation on a topic from Unit 5, followed by a Q & A session. **Deliverables:** Presentation slides, a summary report in 2 to 3 pages and performance during the presentation.
	Implementation: Schedule the seminar presentations at the end of the course.
	Provide clear guidelines and a rubric for evaluation.
	Evaluation and Feedback: Evaluate based on content, delivery and engagement during the Q & A session. Provide feedback on presentation skills and comprehension of the topic.
Open Book Test	**Format:** Analytical and application-based questions to assess depth of understanding.
	Implementation: Schedule the open book test at the end of the course, ensuring it covers critical aspects of Unit 5.
	Evaluation and Feedback: Evaluate based on the depth of analysis and application of concepts.
Quiz	**Format:** Quizzes can help your students practice existing knowledge while stimulating interest in learning about new topic in that course. You can set your quizzes to be completed individually or in small groups.
	Implementation: Online tools and software can be used to create quiz. Each quiz is made up of a variety of question types including multiple choice, missing words, true or false etc.
	Evaluation and Feedback: Evaluate promptly and provide constructive feedback on strengths and areas for improvement.

Schedule for conducting CCE

Duration	Deliverable
Week 1-4	Units 1 and 2
Week 5	Unit Test
Week 6-8	Units 3 and 4
Week 9	Assignments / Case Study
Week 10-12	Unit 5
Week 13	Seminar Presentations / Open Book Test / Quiz

Part II: End-Semester Examination (ESE)

End-Semester Examination (ESE) of 70 marks theory examination based on all the unit of course scheduled by the university. Question papers will be sent by the University through QPD (Question Paper Delivery). University will schedule and conduct ESE at the end of the semester.

Format and Implementation

Question Paper Design: Below structure is to be followed to design an End-Semester Examination (ESE) for a theory subject of 70 marks on all 5 units of the syllabus with questions set as per Bloom's Taxonomy guidelines and 14 marks allocated per unit.

Balanced Coverage: Ensure balanced coverage of all units with questions that assess different cognitive levels of Bloom's Taxonomy: Remember, Understand, Apply, Analyze, Evaluate, and Create.

The questions should be structured to cover:

- Remembering: Basic recall of facts and concepts.
- Understanding: Explanation of ideas or concepts.
- Applying: Use of information in new situations.
- Analyzing: Drawing connections among ideas.
- Evaluating: Justifying a decision or course of action.
- Creating: Producing new or original work (if applicable).

Detailed Scheme for 70 Marks: Unit-Wise Allocation (14 Marks per Unit): Each unit will have a combination of questions designed to assess different cognitive levels. By following this scheme, you can ensure a comprehensive and fair assessment of students' understanding and application of the course material, adhering to Bloom's Taxonomy guidelines for cognitive skills evaluation.

Detailed Scheme for 35 Marks: Unit-Wise Allocation (08 Marks for Unit 1, 09 Marks for Unit 2, Unit 3 and Unit 4): Each unit will have a combination of questions designed to assess different cognitive levels. By following this scheme, you can ensure a comprehensive and fair assessment of students' understanding and application of the course material, adhering to Bloom's Taxonomy guidelines for cognitive skills evaluation.

NEP 2020 Compliant Curriculum Structure
Third Year Engineering (SPPU 2024 Pattern)
Civil Engineering

Level 5.5														
Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks					Credits			
			Theory	Tutorial	Practical	CCE*	End-Sem	Term	Practical	Oral	Theory	Tutorial	Practical	Total
Semester V														
PCC301-CVL	Programme Core Course 1	Design of Steel Structure	3	-	-	30	70	-	-	-	3	0	-	3
PCC302- CVL	Programme Core Course 2	Geotechnical Engineering	3	-	-	30	70	-	-	-	3	0	-	3
PCC303- CVL	Programme Core Course 3	Construction Management	3	-	-	30	70	-	-	-	3	0	-	3
PCC304- CVL	Programme Core Course Lab 1	Geotechnical Engineering Lab	-	-	2	-	-	25	-	25	0	0	1	1
PCC305- CVL	Programme Core Course Lab 2	Design of Steel Structure Lab	-	-	4	-	-	25	-	25	0	0	2	2
PEC321- CVL	Programme Elective Course	(To be selected from list below)	3	-	-	30	70	-	-	-	3	0	-	3
PEC322- CVL	Programme Elective Course Lab 3	(To be selected from list below)	-	-	2	-	-	25	-	-	0	0	1	1
MDM331- CVL	Multidisciplinary Minor	Geo-informatics - I	3	-	-	30	70	-	-	-	3	0	-	3
MDM331- CVL	Multidisciplinary Minor	Geo-informatics - I Lab	-	-	2	-	-	-	-	25	-	0	1	1
OLE341-CVL	Open Elective	(To be selected from basket provided by SPPU)	2	-	-	15	35	-	-	-	2	0	-	2
Total			**17**	**0**	**10**	**165**	**385**	**75**	**0**	**75**	**17**	**0**	**5**	**22**
			27 Hrs.			**700 Marks**					**22 Credits**			

***Note:** Students can opt for Open Electives offered by different faculty like Arts, Science, Commerce, Management, Humanities or Inter-Disciplinary studies.

Programme Elective Course SEM V	Example - Open Elective SEM V
PEC321A- CVL: Advanced Concrete Technology	Human Resource Management
PEC321B- CVL: Open Channel & Fluid Machinery	Construction Laws & Contracts
PEC321C- CVL: AI Applications in Civil Engineering	Environmental Law
PEC321D- CVL: Climate Change & Sustainability	
MDM SEM V– Geo-informatics –I	

NEP 2020 Compliant Curriculum Structure
Third Year Engineering (SPPU 2024 Pattern)
Civil Engineering

Level 5.5														
Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks					Credits			
			Theory	Tutorial	Practical	CCE*	End-Sem	Term work	Practical	Oral	Theory	Tutorial	Practical	Total
Semester VI														
PCC351- CVL	Programme Core Course 1	Design of Reinforced Concrete Structure	3	-	-	30	70	-	-	-	3	0	-	3
PCC352- CVL	Programme Core Course 2	Water Supply and Sanitation Engineering	3	-	-	30	70	-	-	-	3	0	-	3
PCC353- CVL	Programme Core Course Lab 1	Design of Reinforced Concrete Structure Lab	-	-	4	-	-	25	-	25	0	0	2	2
PCC354- CVL	Programme Core Course Lab 2	Water Supply and Sanitation Engineering Lab	-	-	4	-	-	25	-	25	0	0	2	2
PEC361- CVL	Programme Elective Course - 1	(To be selected from list below)	3	-	-	30	70	-	-	-	3	0	-	3
PEC362- CVL	Programme Elective Course -2	(To be selected from list below)	3	-	-	30	70	-	-	-	3	0	-	3
MDM371- CVL	Multidisciplinary Minor	Geo-informatics – II	3	-	-	30	70	-	-	-	3	0	-	3
MDM372- CVL	Multidisciplinary Minor Lab	Geo-informatics – II Lab	-	-	2	-	-	25	-	25	0	0	1	1
VSE373-CVL	Vocational and Skill Enhancement Course	Solar Technology & Maintenance	-	-	2	-	-	50	-	-	0	0	2	2
Total			**15**	**0**	**12**	**150**	**350**	**125**	**0**	**75**	**15**	**0**	**7**	**22**
			27 Hrs.			**700 Marks**					**22 Credits**			

Programme Elective Course:

Programme Elective Course -1 SEM VI	Programme Elective Course- 2 SEM VI
PEC361A- CVL: Hydrology and Water Resource Engineering	PEC362A- CVL: Soft Computing Techniques
PEC361B- CVL: Structural Audit and Retrofitting of Structures	PEC362B- CVL: Solid Waste Management
PEC361C- CVL: Foundation Engineering	PEC362C- CVL: Advanced structural analysis
PEC361D- CVL: Construction Chemicals and Water Proofing	PEC362D- CVL: Plumbing Engineering
MDM SEM VI – Geo-Informatics- II	

SAVITRIBAI PHULE PUNE UNIVERSITY (SPPU), PUNE, MAHARASHTRA, INDIA

TE - CIVIL ENGINEERING

.

Semester – V

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PCC301-CVL **Course: Design of Steel Structures**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Perquisites, if any: Mechanics of Structure, Structural Analysis

Companion course: **Design of Reinforced Concrete Structure**

Course Objectives:

1. To understand the philosophy and codal provisions used in steel structure design and design of tension members.
2. To analyze and design steel compression members and columns.
3. To design flexural members considering strength and serviceability requirements.
4. To design eccentrically loaded columns and suitable column bases.
5. To design plate girders and gantry girders for industrial steel structures.

Course outcomes

On completion of the course, students will be able to:

1. Apply limit state design principles for steel tension members and connections.
2. Design steel compression members and columns using IS code provisions.
3. Design laterally restrained and unrestrained steel beams.
4. Design eccentrically loaded columns and different types of column bases.
5. Design welded plate girders and gantry girders for practical applications.

COURSE CONTENTS

Unit 1	Design philosophy & Tension Members	(09 hours)

Design Philosophy: Types of steel structures & applications, Steel properties, grades, rolled sections, IS Codes overview (IS 800, IS 875, IS 808), Limit State Design philosophy, Load combinations, factor of safety. Introduction to pre-engineered buildings & cold form light gauge section: including concept, components, and advantages. Concept of sustainability in steel construction, including recyclability, resource efficiency, and reduced environmental impact over the structure lifecycle

Design of Tension Members: Tension member: various cross sections such as solid threaded rod, cable and angle sections limit strength due to yielding, rupture and block shear, design of tension members of a truss using single and double angle sections and design of connection.

Unit 2	Design of Compression Members and Columns	(09 hours)

Buckling classification, buckling curves, classification of cross, effective length for compression members and columns, design compressive stress, design of compression member of trusses using single and double angle section and design of connections. Design of axially loaded column using rolled steel section, design of built-up column, lacing and battening and its connections.

Unit 3	Design of Flexural Members	(09 hours)
Design bending strength, laterally restrained and unrestrained beams, design of laterally restrained beams using single rolled steel section with and without flange plate, curtailment of flange plates, low and high shear, check for web buckling, web crippling and deflection. Design of laterally unrestrained beams using single rolled steel section, check for and deflection, design of purlin.		
Unit 4	**Eccentric Loaded Columns & Column Bases**	**(09 hours)**
Design of eccentrically loaded column providing uniaxial and biaxial bending for section strength & Member strength. Design of column bases: slab base, gusseted base and moment resistant base for axial load, uni-axial and bi-axial bending.		
Unit 5	**Design of plate girder & gantry girder**	**(09 hours)**
Design of Welded Plate Girder: Concept of plate girder, components of welded plate girder, intermittent weld, design of cross section, curtailment of flange plates, end bearing, load bearing, and intermediate stiffeners, design of connection between flange & web plate and web plate & stiffeners, check for shear buckling of web, shear capacity of end panel and serviceability condition. **Design of gantry girder:** selection and design of cross section, check for moment capacity, buckling resistance, bi-axial bending, serviceability and fatigue strength.		

LEARNING RESOURCES

Text books

1. Limit State Design of Steel Structures, S K Duggal, Tata McGraw Hill Education, New Delhi
2. Design of Steel Structure by Limit State Method as per IS: 800- 2007, Bhavikatti S S, I. K. International publishing house, New Delhi
3. Design of Steel Structures, K. S. Sai Ram, Pearson, New Delhi

Reference books

1. Design of Steel Structure, N Subramanian, Oxford University Press, New Delhi
2. Limit State Design in Structural Steel, M. R. Shiyekar, PHI, Delhi
3. Fundamentals of structural steel design, M L Gambhir, Tata McGraw Hill Education Private limited, New Delhi.

Links to online SWAYAM/NPTEL Courses

https://nptel.ac.in/courses/105105162

https://nptel.ac.in/courses/105106216

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PCC302-CVL **Course: Geotechnical Engineering**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Perquisites, if any: The basic knowledge of Engineering Mathematics, Physics.

Companion course, if any

Course Objectives:

1. To understand and classify soils based on their formation process and index properties using standard classification systems.
2. To apply concepts of permeability and seepage to analyze soil behavior and construct flow nets for seepage problems.
3. To analyze the effects of compaction on soil properties and evaluate stress distribution in soil masses.
4. To evaluate shear strength characteristics of soils and interpret results from laboratory and field tests under different drainage conditions.
5. To apply bearing capacity theories for estimating the load-carrying capacity of shallow foundations.

Course outcomes :

On completion of the course, students will be able to:

1. Identify and classify the soil based on the index properties and its formation process
2. Explain permeability and seepage analysis of soil by construction of flow net.
3. Illustrate the effect of compaction on soil and understand the basics of stress distribution.
4. Express shear strength of soil and its measurement under various drainage conditions.
5. Estimate the bearing capacity of shallow foundations.

COURSE CONTENTS

Unit 1	Introduction and Index Properties	(09 hours)

Introduction to Geotechnical Engineering and its applications to Civil Engineering. Types of soil structure, major soil deposits of India, Clay Mineralogy and Behavior. Field identification of soils. Introduction to soil exploration: objective and purpose. methods of Investigation: trial pits, borings, depth & number of exploration holes, core recovery, RQD, core log, geophysical methods: seismic refraction and electrical resistivity method)
Three phase soil system: weight – volume relationships, Index properties of soil: Methods of determination and their significance. IS and Unified Soil classification systems, AASHTO, Triangular soil classification.

Unit 2	Permeability and Earth Pressure	(09 hours)

Permeability and Earth Pressure:
Soil water, permeability definition and necessity of its study, Darcy's law, factors affecting permeability. Permeability of stratified soil deposits. Seepage and Seepage Pressure, quick sand phenomenon, critical hydraulic gradient, General flow equation for 2-D flow Laplace equation.
Earth Pressure – Introduction, Rankine's state of Plastic Equilibrium in soils- Active and Passive states due to wall movement, Earth Pressure at rest. Rankine's Theory: Earth pressure on Retaining wall due to submerged backfill.

Unit 3	Compaction and Stress Distribution	(09 hours)

Compaction – Introduction, Comparison between compaction and consolidation. Compaction tests- Standard Proctor test, Modified Proctor test. Zero air void line. Factors affecting compaction. Effect of compaction on soil properties. Field compaction methods and compaction equipment for different types of soil, Placement water content, Field compaction control- use of compaction test result. Proctor needle in field compaction control.

Stress Distribution in Soils – Geostatic stress, Boussinesq's theory with assumptions for point load and circular load (with numerical), Pressure Distribution diagram on a horizontal and vertical plane, Pressure bulb and its significance. Westergaard's theory, equivalent point load method. Approximate stress distribution method.

Unit 4	Shear Strength of Soil	(09 hours)

Introduction – Shear strength an Engineering Property. Mohr's stress circle, Mohr- Coulomb failure theory. The effective stress principle- Total stress, effective stress and neutral stress / pore water pressure. Peak and Residual shear strength, factors affecting shear strength. Stress-strain behaviour of sands and clays.

Measurement of Shear Strength – Direct Shear test, Triaxial Compression test, Unconfined Compression test, Vane Shear test. Their suitability for different types of soils, advantages and disadvantages. Different drainage conditions for shear tests. Sensitivity and thixotropi of cohesive soils. Field tests- SPT, N value correction and significance, DCPT, SCPT and introduction of advanced testing techniques like pressure meter test, borelog, contents of sample soil investigation report.

Unit 5	Bearing Capacity	(09 hours)

Basic definitions, modes of shear failure, bearing capacity analysis- Terzaghi's, and IS code method - rectangular and circular footings, bearing capacity evaluation: plate load test and SPT, Housel's perimeter shear concept, bearing capacity of layered soil, effect of water table on bearing capacity, effect of eccentricity, presumptive bearing capacity.

LEARNING RESOURCES

Text books

1.Soil Mechanics and Foundation Engineering by Dr. B. C. Punmia, Laxmi Publications
2.Geotechnical Engineering by Shashi K. Gulati & Manoj Datta, Tata McGraw Hill.
3. Geotechnical Engineering by T N Ramamurthy & T G Sitharam, S Chand Publications.

Reference books

1. Principles of Geotechnical Engineering by Braj M.Das, Cengage Learning.
2. Geotechnical Engineering by P Purushothma Raj , Tata McGraw Hill.

Links to online SWAYAM/NPTELCourses

1. https://onlinecourses.nptel.ac.in/noc22_ce03/preview
2. https://nptel.ac.in/courses/105105168
3. https://onlinecourses.nptel.ac.in/noc24_ce89/preview

YouTube/Video Links

1. https://youtu.be/i--51DBtOGU?si=VwHEIDXGyvc3qNbr
2. https://youtu.be/JvU-OXOyiTU?si=GuTGRP6fnxRphY0z
3.https://youtu.be/l3KSAhZJH3M?si=AvK6ywIQbYR7SSrE
4. https://youtu.be/a-6YbkZJ5UY?si=bOb_dEb63U7DFLBk
5.https://youtu.be/M4TNKwuSnAk?si=BAHkdcgNmO3VnDVQ

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PCC 303 - CVL **Course: Construction Management**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Perquisites, if any: Project Management

Course Objectives:

1. To introduce construction management concepts and Scheduling and Work Study
2. To understand labour laws and financial aspects
3. To understand risk identification, analysis techniques and value engineering in construction projects
4. To understand material, supply chain management, and AI & emerging technologies in construction.
5. To understand human resource management in construction and BIM

Course outcomes: On completion of the course, students will be able to:

1. Explain construction management concepts and work study techniques
2. Describe important labour laws in construction sector and interpret financial statements
3. Evaluate risks and apply value engineering techniques
4. Explain material management systems and applications of AI and emerging technologies in civil engineering
5. Describe HR management processes in construction projects and BIM concepts & their application in project management

COURSE CONTENTS

Unit I	Overview of Construction Management, Scheduling and Work Study	(09 hours)

Role of construction industry in economic development , Stakeholders in construction projects, Construction management: necessity, Scope and applications, project management consultants: role, types, selection and appointment process, Construction project scheduling: definition, objectives factors affecting scheduling, line of balance technique, Work study (time and motion study): definition, objectives, process of method study, symbols, multiple activity charts, two handed process chart, string diagram.

Unit 2	Labour Laws and Financial Aspects of Construction Project	(09 hours)

Need and importance of labour laws, study of important labour laws associated with construction sector: workman's compensation act 1923, building and other construction workers act 1996, child labour act, interstate migrant workers act, the minimum wages act 1948. Brief introduction to the Labour Codes—Code on Wages, 2019 and Occupational Safety, Health and Working Conditions Code, 2020. Capital investments: importance and difficulties, Sources of finance, working capital requirements, project cash flow projections and statements, project balance sheet, profit loss account statements.

Unit 3	Risk Management and Value Engineering	(09 hours)

Risk Management: introduction, principles, steps in risk management, risk in construction, origin, use of mathematical models: sensitivity analysis, break even analysis, simulation analysis (examples), decision tree analysis, risk identification, mitigation of project risks, role of insurance in risk management and case study on risk management.

Value Engineering: meaning of value, types of value, value analysis, value engineering and its application, energy cost escalation and its impact on infrastructure project.

Unit 4	Material Management and AI Techniques in Civil Engineering	(09 hours)

Material: introduction, need, objectives, functions and scope of material management, integrated concept of material management, material management organization, various phases of material flow system, application of ech phase, role of material manager, role of material management in construction management and its linkage with other functional areas, stores management and control, concept of logistics and supply chain management.
Introduction to artificial intelligence technique, basic terminologies and applications in civil engineering: artificial neural network, fuzzy logic and genetic algorithm, Emerging technologies: IoT in construction, Drones for monitoring, Digital twins (introductory concept)

Unit 5	Human Resource Management and BIM Applications in Construction	(09 hours)

Human resource: introduction, nature and scope of human resource management, human resource in construction sector, staffing policy and patterns, human resource management process, human resource development process, recruitment & selection, performance evaluation and appraisal, training & development, succession planning, compensation and benefits, career planning, human resources information systems, HR data and analytics, role of ERP in human resource management and human resource information system.
BIM (Building Information Modelling): Introduction to BIM concepts and benefits, BIM levels and LOD (Level of Development), Applications of BIM in project planning and coordination, Overview of BIM software tools

LEARNING RESOURCES

Text books

1. Construction Project Management: Planning, Scheduling and Controlling by K. K. Chitkara Tata McGraw Hill.
2. Construction Management: Planning and Finance, K. K. Chitkara Tata McGraw Hill.
3. Project Management by K. Nagarajan, New Age International Publishers.
4. Construction Management and Accounts by, S. K. Sharma Khanna Publishers.
5. Construction Planning and Management by H. K. Gupta CBS Publishers.

Reference books

1. Projects: Planning, Analysis, Selection by Prasanna Chandra Implementation and Review, Tata McGraw Hill.
2. Project Management: A Systems Approach to Planning, Scheduling, and Controlling by Harold Kerzner, Wiley India.
3. Project Management: The Managerial Process by Clifford F. Gray & Erik W. Larson, McGraw Hill.
4. Value Engineering in the Construction Industry by Dell'Isola, Van Nostrand Reinhold.
5. Materials Management: An Integrated Approach by Gopalakrishnan & Sundaresan, PHI Learning.
6. Human Resource Management by K. Aswathappa McGraw Hill Education.
7. BIM Handbook: A Guide to Building Information Modelling, Chuck Eastman, Wiley.
8. Neural Networks, Fuzzy Logic and Genetic Algorithms, S. Rajasekaran & G. A. Vijayalakshmi Pai, PHI Learning.

e-Books

1. Construction Project Management: A Practical Guide to Field Construction Management
2. Authors: S. Keoki Sears, Glenn A. Sears, Richard H. Clough (later editions include Jerald L. Rounds)

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PCC304-CVL **Course: Geotechnical Engineering Lab**

Teaching scheme	Credit	Examination	
Practical: 2 hours / week	01	OR TW	25 marks 25 marks

Perquisites, if any: The basic knowledge of Engineering Mathematic, Physics.

Companion course: **Geotechnical Engineering**

Course Objectives:

1. To develop practical knowledge of soil properties and geotechnical testing procedures through laboratory and field investigations.
2. To provide exposure to soil exploration techniques, data interpretation, and software applications used in geotechnical engineering.

Course outcomes:

On completion of the course, students will be able to:

1. Students will be able to perform laboratory and field tests to determine engineering properties and classification of soils.
2. Students will be able to interpret soil investigation data, prepare reports, and understand practical geotechnical engineering applications through software and site visits.

LIST OF PRACTICALS

The Term work shall consist of

List of Laboratory Experiments (Any Ten) and 13th, 14th & 15th is compulsory

1. Water content determination by any two methods a) Oven drying method, b) calcium carbide method
2. Specific gravity determination by Pycnometer /density bottle.
3. Sieve analysis, particle size determination, and hydrometer analysis, IS classification as per I.S. Codes.
4. Determination of Consistency limits and their use in soil classification as per I.S. Codes.
5. Field density test by a) Core cutter b) Sand Replacement
6. Field test for determination of permeability- Pumping in test and pumping out test.
7. Direct shear test.
8. Unconfined compression test.
9. Vane Shear test.
10. Triaxial test
11. Standard Proctor test / Modified Proctor test.
12. Differential free swell test.
13. Introduction to software Interface (numerical analysis) and Soil Modeling,
Microsoft Excel Assignment etc.
14. Collection and study of sample soil investigation report for any construction project.
15. Site visit at any of the soil investigation work for Bridge, Tunnel, Highway, High rise building, Pilling work etc.

LEARNING RESOURCES

Text books

1.Soil Mechanics and Foundation Engineering by Dr. B. C. Punmia, Laxmi Publications
2.Geotechnical Engineering by Shashi K. Gulati & Manoj Datta, Tata McGraw Hill.
3. Geotechnical Engineering by T N Ramamurthy & T G Sitharam, S Chand Publications.

Reference books

1. Principles of Geotechnical Engineering by Braj M.Das, Cengage Learning.
2. Geotechnical Engineering by P Purushothma Raj , Tata McGraw Hill.

1. Links to online SWAYAM/NPTELCourses

1. https://onlinecourses.nptel.ac.in/noc22_ce03/preview
2. https://nptel.ac.in/courses/105105168
3. https://onlinecourses.nptel.ac.in/noc24_ce89/preview

1. **YouTube/Video Links**

1. https://youtu.be/i--51DBtOGU?si=VwHEIDXGyvc3qNbr
2. https://youtu.be/JvU-OXOyiTU?si=GuTGRP6fnxRphY0z
3.https://youtu.be/l3KSAhZJH3M?si=AvK6ywIQbYR7SSrE
4. https://youtu.be/a-6YbkZJ5UY?si=bOb_dEb63U7DFLBk
5.https://youtu.be/M4TNKwuSnAk?si=BAHkdcgNmO3VnDVQ

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PCC305-CVL **Course: Design of Steel Structures Lab**

Teaching scheme	Credit	Examination	
Practical: 4 hours / week	02	OR TW	25 marks 25 marks

Perquisites, if any: mechanics of structure, structural analysis

Companion course: Design of Steel Structures

Course Objectives:

1. To develop practical skills in analysis, design, and detailing of steel structural components using manual methods, spreadsheets, and software tools.
2. To provide exposure to real industrial steel structures through drafting practice and site visits.

Course outcomes

On completion of the course, students will be able to:

1. Students will be able to analyze, design, and prepare detailing drawings of steel structural components and industrial buildings.
2. Students will be able to use design software, spreadsheets, and field observations for practical understanding of steel structures and connections.

LIST OF PRACTICALS

The Term work shall consist of

Industrial Structures: Components of industrial structure, **Design of Purlin,**

Term work consists of a journal containing the following design, drawing and site visit report. Oral examination will be based on term work.

1. Four full imperial size hand drawn drawing sheets consists of steel structural detailing of 16 sketches based on the syllabus and one full imperial size sheet on Drawings of civil pre-engineered steel buildings.
2. Introduction to Spread sheet-based design, Design of Tension member / Compression member using spreadsheet
3. Design of industrial building including:
   Components of Industrial Building
   Roof truss: assessment of dead load, live load and wind load, Analysis of truss by using suitable software and cross check manually, design of truss members, detailing of typical joints and supports.
   Design of purlin, bracings, gantry girder, column, column base and connections. Spreadsheet may be used for design of gantry girder. Three full imperial size hand drawn drawing sheets present the design details.
4. Design of welded plate girder: design of cross section, curtailment of flange plates, stiffeners and connections. One full imperial size drawing sheet used to present the design details using any suitable software.

   OR

   Design of building including primary and secondary beams, column, column base and connections. Analysis of building by using any suitable software and design manual. One full imperial size drawing sheet used to present the design details using any suitable software.
5. Compulsory two site visits based on industrial steel structure and welded plate girder Report should contain structural details with sketches.

LEARNING RESOURCES

Text books

1. Limit State Design of Steel Structures, S K Duggal, Tata McGraw Hill Education, New Delhi
2. Design of Steel Structure by Limit State Method as per IS: 800- 2007, Bhavikatti S S, I. K. International publishing house, New Delhi

3. Design of Steel Structures, K. S. Sai Ram, Pearson, New Delhi

Reference books

1. Design of Steel Structure, N Subramanian, Oxford University Press, New Delhi
2. Limit State Design in Structural Steel, M. R. Shiyekar, PHI, Delhi
3. Fundamentals of structural steel design, M L Gambhir, Tata McGraw Hill Education Private limited, New Delhi.

Links to online SWAYAM / NPTEL Courses

https://nptel.ac.in/courses/105105162

https://nptel.ac.in/courses/105106216

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PEC321A - CVL **Course: Advanced Concrete Technology**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Perquisites, if any:
Knowledge of basic Concrete Technology including properties of cement, aggregates, fresh and hardened concrete, concrete mix design, durability concepts, and standard laboratory testing procedures.

Course Objectives:

1. To develop an understanding of advanced cementitious materials and their role in modern concrete technology.
2. To study performance-based mix design approaches and evaluate the behavior of advanced concretes.
3. To understand modern concreting technologies and their application in construction practices.
4. To examine durability aspects of concrete, including deterioration mechanisms and factors affecting service life.
5. To introduce sustainable concrete technologies along with repair, rehabilitation, and recent advancements in concrete engineering.

Course outcomes: On completion of the course, students will be able to:

1. Explain advanced hydration, microstructure, and performance characteristics of concrete.
2. Design specialized concrete mixes for various applications.
3. Evaluate durability and service-life performance of concrete structures.
4. Perform advanced testing and quality assessment of concrete.
5. Recommend suitable repair, retrofitting, and sustainable concrete solutions.

COURSE CONTENTS

Unit I	Supplementary Cementitious Materials and Advanced Cement Systems	(09 hours)

Fly ash, GGBS, silica fume, metakaolin, rice husk ash and other pozzolanic materials. Hydration and microstructure of cementitious systems. Interfacial transition zone. Chemical admixtures: Superplasticizers, shrinkage reducing admixtures, corrosion inhibiting admixtures. Rheology of concrete. Nano materials in concrete: Nano silica, carbon nanotubes, graphene oxide.

Unit 2	Performance-Based Concrete and Advanced Mix Design	(09 hours)

Performance requirements for concrete. Limitations of nominal and conventional mix design methods. Performance-based mix proportioning. Packing density approach. Mix design and properties of High Strength Concrete (HSC), High Performance Concrete (HPC), Self-Compacting Concrete (SCC), Fiber Reinforced Concrete (FRC), and Ultra High-Performance Concrete (UHPC). Quality control and statistical concepts in concrete production.

Unit 3	Durability and Service Life of Concrete	(09 hours)

Durability concepts and service life approach. Transport mechanisms in concrete. Chloride ingress, carbonation, sulphate attack, alkali aggregate reaction. Corrosion of reinforcement: Mechanism, initiation and propagation. Durability provisions in IS codes and international practices. Durability assessment and service life prediction of reinforced concrete structures. Concrete for marine and aggressive environments.

Unit 4	Advanced Concrete Construction and Evaluation Techniques	(09 hours)

Ready Mix Concrete (RMC) production and quality control. Pumped concrete and mass concreting. Precast and prestressed concrete production techniques. 3D printed concrete and digital fabrication. Non-destructive and semi-destructive testing methods: Rebound hammer, ultrasonic pulse velocity, pull-out test, core testing, half-cell potential test. Structural health monitoring of concrete structures

Unit 5	Repair, Rehabilitation and Sustainable Concrete Technology	(09 hours)

Assessment and diagnosis of distressed concrete structures. Crack evaluation and corrosion assessment. Repair materials and methods: Epoxy injection, grouting, shotcrete, polymer modified mortar. Retrofitting techniques using FRP and jacketing. Self-healing concrete. Green concrete and recycled aggregate concrete. Carbon footprint reduction and life cycle assessment of concrete structures.

LEARNING RESOURCES

Text books

1. Concrete Technology, Adam M. Neville, J. J. Brooks, Pearson Education
2. Concrete Technology, M. Gambhir, Tata McGraw-Hill Publishing Company

Reference books

1. Properties of Concrete, A. M. Neville, Pearson Education.
2. Concrete: Microstructure, Properties, and Materials, P. Kumar Mehta and Paulo J.M. Monteiro (McGraw Hill Education).

Links to online SWAYAM/NPTELCourses

https://nptel.ac.in/courses/105106176

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PEC321B-CVL **Course : Open Channel Hydraulics and Fluid Machinery**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Perquisites, if any: Fluid Mechanics

Course Objectives:

1. To understand gradually varied flow conceptually.
2. To study hydraulic jump phenomenon
3. To study and understand impulse momentum concept
4. To understand basics of water lifting devices
5. To study concept of hydropower generation devices.

Course outcomes

On completion of the course, students will be able to:

1. Apply knowledge of gradually varied flow to solve water resources problems practically.
2. Solve energy dissipation problems and provide solution to them.
3. Understand fundamentals of fluid machinery.
4. Apply solutions to water lifting issues in water resources.
5. Understand fundamentals of hydropower generation.

COURSE CONTENTS

Unit 1	Gradually varied flow	(09 hours)

Introduction to open channel, different flows for flow through open channel ,non-uniform steady flow-equations for gradually varied flow- classification of flow profile, various water surface profiles (flow profiles), Analysis of flow profile, uniform flow computation, Direct Step method, Graphical methods.

Unit 2	Rapidly Varied flow	(09 hours)

Introduction, Concept of a hydraulic jump, classification of a hydraulic jump, characteristics of jumps, characteristics of jump in rectangular channel, Location of hydraulic jump, use of jump as an energy dissipators, Types of energy dissipators and design

Unit 3	Impact of Jet	(09 hours)

Impulse momentum equation, Impact of jet on fixed vertical flat plate, moving vertical flat plate, curved vanes with special reference to turbines and pumps, Numerical on above conditions Layout of hydroelectric power plant and function of each component.

Unit 4	Centrifugal pump	(09 hours)

Introduction, Water lifting devices used in Ancient India (IKS), Classification, Construction and working principle of Centrifugal pump, Types of casings and impellers, Priming methods, Static head, Manometric head, NPSH, Work done, Manometric efficiency, Overall efficiency, Numerical on above parameters, Performance Characteristics of Centrifugal pumps, Troubleshooting, Construction, working and applications of multistage pump Introduction to Reciprocating Pump

Unit 5	Hydraulic Turbines	(09 hours)

Introduction, Classification of hydraulic turbines, working principle, velocity diagram and applications of Pelton wheel, Kaplan turbine and Francis turbine, Draft tubes: Types, Concept of cavitation in turbines, Calculation of Work done, Power output, efficiency of Pelton turbine only, Criteria for selection of hydraulic turbines and performance characteristics, Design of Pelton wheel turbine, Surge tank- types and importance

LEARNING RESOURCES

Text books

1. Fluid Mechanics and Fluid Machinery - Dr R.K.Bansal , Laxmi Publications (P) Ltd
2. Fluid Mechanics and Fluid Machines- Er R. K.Rajput, S. Chand Publications

Reference books

1. Fluid Mechanics and Fluid Machinery - S.K. Som , Gautam Biswas, McGraw Hill Publications
2. Flow in Open Channel – K Subramanya, McGraw Hill Publications
3. Open Channel Hydraulics- Ven Te Chow, McGraw Hill Publications

Links to online SWAYAM/NPTEL Courses

https://nptel.ac.in/courses/105105203

http://www.digimat.in/nptel/courses/video/105103192/L34.html

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PEC321C-CVL **Course: AI Applications in Civil Engineering**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Perquisites: Familiarity with fundamental civil engineering concepts such as structural behavior, soil properties, and transportation systems is recommended. No programming experience is required.

Course Objectives:

1. To introduce the fundamental concepts and scope of artificial intelligence in civil engineering applications.
2. To develop understanding of data-driven approaches and their relevance in solving civil engineering problems.
3. To familiarize students with basic AI techniques and methodologies used in engineering analysis.
4. To explore applications of artificial intelligence in structural, geotechnical, transportation, and construction engineering domains.
5. To provide exposure to emerging industry tools and demonstrate AI-based solutions for civil engineering problems.

Course outcomes

After completion of the course, students will be able to:

1. Explain the role of data and the fundamental concepts of AI, machine learning, and deep learning in civil engineering, and distinguish between conventional and data-driven approaches.
2. Describe the conceptual foundations of regression, decision trees, neural networks, and deep learning, including model training, testing, overfitting, and generalization.
3. Identify and evaluate applications of AI across civil engineering sub-disciplines, interpreting model inputs and outputs in an engineering context.
4. Demonstrate familiarity with non-coding AI tools and platforms, understanding practical demonstrations of AI applications and their integration with BIM, smart infrastructure, and digital construction.
5. Critically assess the limitations, ethical considerations, and emerging trends of AI in civil engineering, and articulate informed perspectives on its future role in the profession.

COURSE CONTENTS

Unit 1	Introduction to Data and Artificial Intelligence in Civil Engineering	(09 hours)

Role of data in civil engineering practice, need for data-driven approaches, basic concepts of Artificial Intelligence, Machine Learning, and Deep Learning, types of engineering problems such as prediction and classification, types of data in civil engineering including numerical, image, and sensor data, comparison between conventional empirical methods and AI-based approaches.

Unit 2	Fundamental Machine Learning and AI Techniques	(09 hours)

Regression techniques for prediction problems, decision trees for rule-based decision making, artificial neural networks including input–hidden–output representation, introduction to deep learning and computer vision applications, model training and testing, overfitting and generalization, importance of data quality and quantity for model performance.

Unit 3	Applications of AI in Civil Engineering	(09 hours)

Applications in structural engineering including prediction of compressive strength, durability assessment, corrosion prediction, and structural health monitoring; applications in geotechnical engineering such as soil classification, settlement prediction, and bearing capacity estimation; applications in transportation engineering including traffic flow prediction and accident analysis; applications in construction management including cost estimation, time prediction, and risk assessment; interpretation of model inputs and outputs in engineering context.

Unit 4	Tools, Demonstrations, and Industry Practices	(09 hours)

Introduction to generative AI tools for report generation, data interpretation, and engineering assistance. Overview of AI tools and platforms with emphasis on non-coding approaches, spreadsheet-based tools, and AutoML platforms. Demonstration of selected applications such as strength prediction, crack detection, and image-based assessment. Role of AI in Building Information Modelling (BIM), digital construction, and smart infrastructure systems. Integration of AI with monitoring technologies, sensors, and data acquisition systems.

Unit 5	Limitations, Ethics, and Future Scope of AI in Civil Engineering	(09 hours)

Limitations of AI techniques including data dependency, lack of transparency, and reliability concerns, comparison with traditional engineering judgment and code-based design, ethical considerations in safety-critical infrastructure, data bias and decision-making issues, emerging trends such as smart cities, digital twins, and AI-assisted design, future scope of intelligent systems in civil engineering practice.

LEARNING RESOURCES

Text books

1. Machine Learning for Civil and Environmental Engineers A Practical Approach To Data Driven
2. Analysis Explain ability and Causality, M.Z. Naser (Wiley India)

Reference books

1. Applications of Artificial Neural Networks and Machine Learning in Civil Engineering, Ali Kaveh (Springer Cham)
2. Artificial Intelligence in Civil Engineering, Editors - Gebrail Bekdaş, Sinan Melih Nigdeli (Springer Cham)
3. Artificial Intelligence and Machine Learning Techniques for Civil Engineering, Vagelis Plevris, Afaq Ahmad and Nikos D. Lagaros (IGI Global Scientific Publishing)

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PEC321D-CVL **Course: Climate Change and Sustainability**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Course Objectives:

1. Develop understanding of climate systems, climate change science, and its causes.
2. Familiarize students with impacts of climate change on environment, society, and engineering systems.
3. Introduce concepts of sustainable development, SDGs, and sustainability principles.
4. Provide knowledge of mitigation, adaptation, and sustainable technologies.
5. Enable application of sustainability concepts in engineering design and decision-making.

Course outcomes

After completion of the course, students will be able to:

1. Explain fundamentals of climate science and sustainability concepts.
2. Analyze causes and impacts of climate change on natural and built environment.
3. Apply sustainability tools such as LCA, carbon footprint, and resource efficiency.
4. Evaluate mitigation and adaptation strategies in engineering systems.
5. Integrate sustainability principles into engineering design and policy decisions.

COURSE CONTENTS

Unit I	Fundamentals of Climate Change	(09 hours)

Weather vs Climate, atmospheric structure, Earth's energy balance, greenhouse effect, Greenhouse gases (CO_2, CH_4, N_2O),Carbon cycle and climate forcing, Evidence of climate change (temperature rise, sea level, glaciers), Natural vs anthropogenic causes

Unit 2	Impacts of Climate Change	(09 hours)

Global warming and extreme events Impacts on: Water resources, Agriculture and food security, Biodiversity and ecosystems, Human health and urban systems, Climate change and infrastructure, Vulnerability and risk assessment

Unit 3	Sustainability and Sustainable Development	(09 hours)

Concept of sustainability (environmental, economic, social), Sustainable Development Goals (SDGs), Ecological footprint, carbon footprint, Environmental ethics and climate justice, Circular economy and resource efficiency, Role of engineers in sustainability

Unit 4	Mitigation and Adaptation Strategies	(09 hours)

Climate change mitigation: Renewable energy (solar, wind, bioenergy), Energy efficiency and low-carbon technologies, Adaptation strategies:, Water management, Climate-resilient infrastructure, Disaster risk reduction, Carbon sequestration and carbon trading, Policy instruments and international agreements (Paris Agreement, UNFCCC)

Unit 5	Sustainable Engineering Practices & Case Studies	(09 hours)

Sustainable design principles, Life Cycle Assessment (LCA), Green buildings and sustainable cities, Sustainable transportation systems, Waste management and industrial ecology, Case studies (Indian and global examples)

LEARNING RESOURCES

Text books

Reference books

1. David T. Allen & David R. Shonnard – Sustainable Engineering: Concepts, Design and Case Studies.
2. IPCC Reports – Climate Change Assessment Reports
3. Daniel B. Botkin & Edward A. Keller – Environmental Science
4. Michael L. Weitzman – Climate Change Economics
5. UNEP – Global Environment Outlook

e-Books

1. Intergovernmental Panel on Climate Change (IPCC): https://www.ipcc.ch
2. United Nations SDGs: https://sdgs.un.org
3. NASA Climate Change Portal
4. Ministry of Environment, Forest and Climate Change (India)
5. UNFCCC (United Nations Framework Convention on Climate Change)

Links to online SWAYAM/NPTELCourses

1. NPTEL: Environmental Sustainability / Climate Change
2. SWAYAM: Courses on Sustainable Development
3. Coursera: “Climate Change Science and Negotiations” (University of Copenhagen)
4. edX: “Sustainability and Development” (Columbia University)
5. FutureLearn: Climate Change and Resilience courses

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PEC322A - CVL **Course: Advance Concrete Technology Lab**

Teaching scheme	Credit	Examination	
Practical: 2 hours / week	01	TW	25 marks

Perquisites, if any: Knowledge of basic Concrete Technology including properties of cement, aggregates, fresh and hardened concrete, concrete mix design, durability concepts, and standard laboratory testing procedures.

Course Objectives:

1. To develop an understanding of advanced cementitious materials, performance-based mix design, and modern concreting technologies used in civil engineering applications.
2. To study durability aspects of concrete structures along with deterioration mechanisms, and explore sustainable practices, repair techniques, and recent developments in concrete engineering.

Course outcomes

On completion of the course, students will be able to

1. Characterize supplementary cementitious materials and evaluate fresh, mechanical, and durability properties of advanced concretes such as HPC, SCC, and FRC through appropriate laboratory tests.
2. Apply non-destructive testing methods and sustainable concrete practices, and relate laboratory and field observations through technical visits to understand modern concreting technologies and quality control in construction.

LIST OF PRACTICALS

The Term work shall consists of

1. **Characterization of supplementary cementitious materials**
   Determination of fineness, specific gravity and consistency characteristics of fly ash, GGBS, silica fume and other supplementary cementitious materials.
2. **Design and testing of High-Performance Concrete (HPC)**
   Mix design of HPC and determination of workability and compressive strength characteristics.
3. **Tests on Self Compacting Concrete (SCC)**
   Slump flow, L-box, V-funnel and J-ring tests on SCC.
4. **Tests on Fiber Reinforced Concrete (FRC)**
   Determination of compressive strength, split tensile strength and flexural strength of fiber reinforced concrete.
5. **Durability tests on concrete**
   Sorptivity test, carbonation depth test and accelerated corrosion test on concrete.
6. **Non-destructive and semi-destructive testing of concrete**
   Demonstration / Visit-based study of pull-out test, core testing and half-cell potential test.
7. **Sustainable concrete**
   Preparation and testing of concrete using recycled aggregates and supplementary cementitious materials.
8. **Technical visits**
   Visit to one or more of the following: (a) Ready-mix concrete (RMC) plant, (b) Precast concrete manufacturing yard, (c) Construction site involving advanced concreting practices, (d) Repair and rehabilitation project site, (e) Concrete research/testing laboratory.

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PEC322B-CVL **Course: Open Channel Hydraulics and Fluid Machinery Lab**

Teaching scheme	Credit	Examination	
Practical: 2 hours / week	01	TW	25 marks

Perquisites, if any: Concrete Technology

Course objectives:

1. To provide practical understanding of fluid flow phenomena in open channels, hydraulic machines, and impact of jets through laboratory experimentation.
2. To develop the ability to analyze hydraulic jump characteristics, gradually varied flow profiles, and energy dissipation mechanisms in open channel flow.
3. To familiarize students with the operating principles, performance characteristics, and efficiency evaluation of turbines and centrifugal pumps.
4. To enable students to apply principles of fluid mechanics and hydraulic engineering for solving design and numerical problems related to hydraulic structures and hydraulic machines.
5. To enhance experimental, analytical, and report-writing skills through laboratory investigations and engineering problem-solving exercises.

Course outcomes: On completion of the course, students will be able to:

1. Perform and interpret experiments related to open channel flow, hydraulic jump, impact of jet, turbines, and centrifugal pumps using standard laboratory procedures.
2. Analyze gradually varied flow and hydraulic jump characteristics in open channels using hydraulic principles and engineering calculations.
3. Evaluate the performance parameters and efficiencies of hydraulic turbines and centrifugal pumps from experimental observations.
4. Design and solve engineering problems related to hydraulic machines and open channel flow, including Pelton wheel turbine design and flow profile computations.
5. Prepare technical reports and present experimental findings with proper analysis, interpretation, and engineering conclusions.

LIST OF PRACTICALS

The Term work shall consist of the following

A) Experiments B) Assignments

A) Any three experiments from the list

1. Hydraulic jump as energy dissipaters for open channel
2. To verify Impulse-momentum principle for impact of jet on stationary vane.
3. Performance test on Pelton / Francis turbine.
4. Performance test on centrifugal pump.

B) All assignments are compulsory

1. Problem of direct step method for gradually varied flow.
2. Problem on hydraulic jump in wide rectangular channel.
3. Problem on design of Pelton Wheel Turbine.

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PEC322C-CVL **Course: AI Applications in Civil Engineering Lab**

Teaching scheme	Credit	Examination	
Practical: 2 hours / week	01	TW	25 marks

Perquisites, if any: Familiarity with fundamental civil engineering concepts such as structural behavior, soil properties, and transportation systems is recommended. No programming experience is required.

Course Objectives: This course introduces the concepts and applications of artificial intelligence in civil engineering, focusing on data-driven approaches, fundamental techniques, and applications across structural, geotechnical, transportation, and construction domains, with emphasis on conceptual understanding, demonstrations, and emerging industry tools.

Course outcomes:

On completion of the course, students will be able to identify and evaluate applications of AI across civil engineering sub-disciplines, interpreting model inputs and outputs in an engineering context.

LIST OF PRACTICALS

The Term work shall consists of

1. **Introduction to AI tools for civil engineering**
   Demonstration and use of generative AI and non-coding AI tools for engineering calculations, report generation, data interpretation, and technical summarization.
2. **Spreadsheet-based prediction of concrete strength**
   Use of spreadsheet tools to study the relationship between water-cement ratio and compressive strength using regression-based trend analysis.
3. **Prediction of soil properties using spreadsheet tools**
   Prediction and interpretation of soil parameters such as bearing capacity or settlement using simple data-driven approaches.
4. **Traffic data analysis and prediction**
   Collection and analysis of traffic volume data using spreadsheets and graphical tools for trend identification and basic prediction.
5. **AI-based crack detection demonstration**
   Study and interpretation of crack images using image-based AI tools and comparison with manual inspection methods.
6. **Construction project data analysis**
   Analysis of construction project data for estimation of cost, duration, and risk using spreadsheet-based tools and charts.
7. **Demonstration of AutoML tools for civil engineering applications**
   Use of AutoML platforms for prediction problems such as concrete strength, traffic flow, or soil classification without programming.
8. **Case study on AI applications in civil engineering**
   Study and presentation of applications of AI in structural health monitoring, smart infrastructure, BIM integration, digital construction, or sustainable infrastructure systems.
9. **Case study on AI based population forecasting**
   Study and presentation of applications of AI based population forecasting.

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PEC322D-CVL **Course : Climate Change and Sustainability- Lab**

Teaching scheme	Credit	Examination	
Theory: 02 hours / week	01	TW	25 marks

Perquisites: **Basics of Environmental studies, climate change phenomenon.**

Companion course: **Environmental studies**

Course Objectives:

1. To introduce students to the concepts of climate change, sustainability, and environmental impacts associated with civil engineering activities.
2. To develop the ability to assess greenhouse gas emissions, climate vulnerabilities, and carbon sequestration potential using appropriate methodologies and tools.
3. To provide practical exposure to sustainable engineering practices such as rainwater harvesting, green building assessment, life cycle assessment, and circular economy approaches in construction.
4. To familiarize students with sustainability frameworks, SDG mapping techniques, and green building rating systems including IGBC, GRIHA, and LEED.
5. To enable students to use modern environmental assessment software tools such as Open LCA and Sima Pro for evaluating sustainable solutions and preparing climate action plans.

Course outcomes:

On completion of the course, students will be able to:

1. Analyze and quantify greenhouse gas emissions, climate vulnerabilities, and carbon sequestration potential associated with urban infrastructure and construction activities using standard assessment methods and tools.
2. Design sustainable engineering solutions such as rooftop rainwater harvesting systems and climate-responsive campus action plans considering environmental, technical, and societal requirements.
3. Evaluate construction materials, green building practices, and circular economy approaches through Life Cycle Assessment (LCA), recycling studies, and sustainability rating frameworks such as IGBC, GRIHA, and LEED.
4. Apply sustainability assessment tools and software including Open LCA and Sima Pro to interpret environmental impacts and support sustainable decision-making in civil engineering projects.
5. Integrate Sustainable Development Goals (SDGs), climate resilience principles, and resource-efficient practices into civil engineering planning, design, and project evaluation.

LIST OF PRACTICALS

The Term work shall consists of Journal containing any of the 8 practical's from the following list.

1. Analysis of Greenhouse Gas Emissions: Estimation of CO_2 emissions from Construction activities and preparation of emission inventory.
2. Vulnerability Assessment of Urban Area: Identification of climate risks: Flooding, Heat waves, Water scarcity and Preparation of vulnerability maps.
3. SDG Mapping Exercise: Mapping civil engineering projects with Sustainable Development Goals (SDGs), and preparation of SDG compliance matrix.
4. Rainwater Harvesting Design: Design of rooftop rainwater harvesting system for Residential building, Institutional building.
5. Life Cycle Assessment (LCA) of Construction Material: Conventional Concrete, Fly ash concrete.
6. Green Building Rating Study: Study of green building criteria under IGBC, GRIHA, LEED systems.

7. **Study of Carbon Sequestration Techniques:** Estimation of carbon sequestration by Trees, Green belts, urban vegetation.
8. **Circular Economy in Construction:** Study and documentation of reuse of construction materials, recycling practices, industrial by-products in concrete.
9. **Demonstration of LCA Software:** Open LCA, Sima Pro.
10. **Capstone Project:** Preparation of Climate Action Plan for Campus.

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course Code: MDM331-CVL **Course: Geo-informatics - I**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 Marks 70 Marks

Perquisites: Basic knowledge of surveying and computer fundamentals

Companion course: Surveying, Environmental Engineering

Course Objectives:

This course introduces engineering students to Geo-informatics in Civil Engineering. The basic objectives are:

1. To introduce the fundamentals of Geo-informatics including GIS, Remote Sensing and GNSS.
2. To develop understanding of geospatial data concepts, acquisition and management techniques.
3. To explain principles of remote sensing and basic Digital Image processing techniques.
4. To impart knowledge of GNSS and its applications in surveying and mapping.
5. To introduce GIS concepts and spatial analysis techniques for civil engineering applications.

Course outcomes:

On completion of the course, students will be able to:

1. Explain the fundamental concepts of Geo-informatics and its applications in Civil Engineering.
2. Describe the principles of Remote Sensing and Digital Image Processing for interpretation of geospatial data.
3. Explain the fundamentals of GNSS and its applications in surveying and mapping.
4. Demonstrate understanding of GIS concepts for spatial data handling, database management and mapping.
5. Apply spatial analysis techniques and terrain modeling concepts for civil engineering applications.

COURSE CONTENTS

Unit 1	Introduction to Geo-informatics	(09 hours)

Definition and scope of Geo-informatics, components and evolution of Geo-informatics technology. Importance in engineering and applications. Nature and characteristics of geospatial data. Advantages and limitations of Geo-informatics. Challenges in geospatial data handling and analysis.

Emerging trends such as Web GIS, cloud computing and AI integration. Role of Geo-informatics in civil engineering applications and its benefits.

Unit 2	Remote Sensing & Digital Image Processing	(09 hours)

Basics of Remote Sensing including electromagnetic radiation (EMR), electromagnetic spectrum and platforms. Principles of EMR interaction with atmosphere and earth surface, atmospheric window.

Sensors and platforms including Indian and global satellites. Image interpretation elements such as tone, texture, pattern, shape, size, shadow and association.

Introduction to digital image concepts, basic preprocessing (geometric and radiometric correction) and enhancement techniques (contrast stretching, filtering). Spectral signatures and their importance in feature identification. Overview of image classification (supervised and unsupervised) and accuracy assessment.

Unit 3	GNSS & Surveying Applications	(09 hours)

Fundamentals of GNSS including GPS and IRNSS/NavIC systems. Differential GPS (DGPS): principle, working methodology, types (static and real-time DGPS). Accuracy improvement techniques. Sources of errors in GNSS and correction techniques. Applications in surveying, mapping and civil engineering projects such as route alignment and infrastructure planning.

Unit 4	Geographic Information Systems (GIS)	(09 hours)

GIS concepts and components. Spatial data models including vector and raster data structures. Coordinate systems and map projections. Data input methods such as digitization, scanning and GPS data collection. Database management concepts and attribute data handling. GIS database and DBMS basics.
Introduction to GIS software such as QGIS (conceptual overview and applications).

Unit 5	Spatial Analysis & Terrain Modeling	(09 hours)

Spatial data analysis concepts and spatial queries. Overlay analysis, buffering and clipping operations. Network analysis fundamentals. Digital Elevation Model (DEM) concepts and data sources. Terrain analysis including slope, aspect and contour generation. TIN model basics. Error sources and accuracy assessment in spatial analysis.

Learning Resources

Textbooks

- "Remote Sensing and GIS" – Basudeb Bhatta A comprehensive book covering GIS, remote sensing, GPS, and geospatial analysis; widely used for civil engineering and geoinformatics courses.
- "Geographic Information Systems" – Kang-Tsung Chang Covers GIS fundamentals, data models, and spatial analysis concepts.
- "Principles of Geographic Information Systems" – P.A. Burrough & R.A. McDonnell Standard reference for GIS theory and applications.

Reference Books

- "Remote Sensing and Image Interpretation" – Lillesand, Kiefer & Chipman Classic book for understanding remote sensing principles and image analysis.
- "Advances in Geoinformatics: Remote Sensing and GIS" – Bhunia et al. Covers modern techniques and applications in geoinformatics.
- "Applications of Geomatics in Civil Engineering" – J.K. Ghosh et al. Focuses on real-world civil engineering applications using geospatial technologies.
- "Application of Remote Sensing and GIS in Natural Resources and Built Infrastructure Management" – V.P. Singh et al. Useful for advanced application-based understanding.

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: MDM331-CVL **Course: Geo-informatics - I Lab**

Teaching scheme	Credit	Examination	
Practical: 2 hours / week	01	OR	25 marks

Perquisites, if any: Basic knowledge of surveying and computer fundamentals.

Companion course: Geo-informatics - I

Course Objectives:

This course introduces engineering students to Geo-informatics in Civil Engineering. The basic objectives are:

1. To introduce the fundamentals of Geo-informatics including GIS, Remote Sensing and GNSS.
2. To develop understanding of geospatial data concepts, acquisition and management techniques.
3. To explain principles of remote sensing and basic Digital Image processing techniques.
4. To impart knowledge of GNSS and its applications in surveying and mapping.
5. To introduce GIS concepts and spatial analysis techniques for civil engineering applications.

Course outcomes:

On completion of the course, students will be able to:

1. Explain the fundamental concepts of Geo-informatics and its applications in Civil Engineering.
2. Describe the principles of Remote Sensing and Digital Image Processing for interpretation of geospatial data.
3. Explain the fundamentals of GNSS and its applications in surveying and mapping.
4. Demonstrate understanding of GIS concepts for spatial data handling, database management and mapping.
5. Apply spatial analysis techniques and terrain modeling concepts for civil engineering applications.

LIST OF PRACTICALS

The Term work shall consist of

1. Introduction to Geo-informatics Software Environment

Study of Geo-informatics laboratory setup and introduction to GIS, Remote Sensing and GNSS software interfaces such as QGIS and ArcGIS. Familiarization with menus, toolbars, coordinate display and project workspace.

2. Study of Geospatial Data Types and Formats

Identification and comparison of raster and vector data formats such as SHP, GeoJSON, TIFF, JPEG, KML and DXF. Understanding attribute tables and metadata.

3. Coordinate Systems and Map Projection Exercise

Study and visualization of geographic and projected coordinate systems. Understanding latitude–longitude system, UTM projection and datum concepts using GIS software.

4. Downloading and Visualization of Open Geospatial Data

Downloading satellite imagery, DEM and vector datasets from platforms such as:

- Bhuvan
- USGS Earth Explorer
- OpenStreetMap

Visualization and layer management in GIS software.

5. Basic Map Creation and Layout Preparation

Preparation of simple maps using GIS software including:

- Adding title

- Legend
- North arrow
- Scale
- Coordinate grid
- Exporting map layout

6. Introduction to Remote Sensing Imagery

Study of different satellite images and identification of basic features such as vegetation, water bodies, roads and built-up areas using visual interpretation elements.

7. Spectral Signature and Band Combination Study

Understanding RGB band combinations and spectral response of various earth surface features using multispectral satellite imagery.

8. Basic Image Enhancement Techniques

Performing simple image enhancement operations such as:

- Brightness adjustment
- Contrast stretching
- False color composite generation

9. GNSS/GPS Observation Exercise

Collection of GPS coordinates using mobile GPS/GNSS applications or handheld devices and plotting locations on GIS platform.

10. Introduction to Spatial Query and Attribute Operations

Basic querying operations in GIS software using:

- Select by attribute
- Select by location
- Simple filtering and sorting of spatial data

11. Introduction to Buffer and Measurement Tools

Use of GIS tools for:

- Distance measurement
- Area calculation
- Perimeter calculation
- Simple buffer generation around roads or points

12. Mini Assignment / Viva

Small assignment based on:

- Preparation of a simple geospatial map
  OR
- Data visualization and interpretation using open datasets.

SAVITRIBAI PHULE PUNE UNIVERSITY (SPPU), PUNE, MAHARASHTRA, INDIA

TE - CIVIL ENGINEERING

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Semester – VI

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PCC351-CVL **Course: Design of Reinforced Concrete Structures**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Perquisites: Fundamentals of Concrete Technology, Engineering Mechanics, Mechanics of Materials and Structural Analysis.

Course Objectives:

1. To understand the design philosophy and limit state method for reinforced concrete structures.
2. To design one-way and two-way reinforced concrete slabs with proper detailing.
3. To design reinforced concrete staircases and beams subjected to flexure, shear, bond, and torsion.
4. To analyse and design continuous reinforced concrete beams using codal provisions.
5. To design reinforced concrete columns and isolated footings subjected to various loading conditions.

Course outcomes

On completion of the course, students will be able to:

1. Apply relevant IS provisions to ensure safety and serviceability of structures, recognize mode of failure as per LSM and evaluate moment of resistance for singly, doubly rectangular, and flanged sections.
2. Design and create detailed technical drawings for one-way and two-way floor slabs based on how they are supported at the edges.
3. Design & detailing of dog legged and open well staircase and Design & detailing of singly/doubly rectangular/flanged beams for flexure, shear, bond and torsion.
4. Design & detailing of continuous beams IS code method and Moment Redistribution.
5. Design and detailing of reinforced columns that carry axial, uniaxial and biaxial loads, along with the foundations required to support them.

COURSE CONTENTS

Unit 1	Fundamentals of Limit State Design for Reinforced Concrete and Sectional Analysis	(09 hours)

Design philosophies of RC structures: working stress method and limit state method, Limit state method: limit state of collapse, limit state of serviceability and limit state of durability, characteristic strength, characteristic load, partial safety factors. structural properties of concrete and reinforcing steel, assumptions of limit state method, strain variation diagram, stress variation diagram, design parameters for singly reinforced rectangular section, modes of failure, moment of resistance of singly and doubly reinforced rectangular section, singly reinforced flanged section.

Unit 2	Design of Slab	(09 hours)

Introduction to Slab Design, Types of slabs, Design procedure for One way simply supported, Cantilever and Continuous slabs. Design procedure for Two way simply supported, continuous and restrained slabs along with detailing of reinforcement for all slab as per SP-34 & IS-13920.

Unit 3	Design of Staircase and Beams	(09 hours)

Introduction to vertical circulation elements (staircase), Types of staircases, Design procedure for Dog-legged and Open well staircase and its reinforcement detailing as per SP-34 & IS-13920.

Design of simply supported and cantilever beams for flexure (singly reinforced, doubly reinforced and flanged), Introduction to shear, bond and torsion and its application in design of simply supported beams.

Unit 4	Design of continuous Beams	(09 hours)

Introduction to Continuous beams and its Analysis, Methods of design of continuous beams, Design and Detailing of rectangular and flanged cross section for continuous beam by using IS Code Coefficients method (IS 456: 2000) and Moment Redistribution method.

Unit 5	Design of Column and its Footings	(09 hours)

Introduction to Column and its types, Assumptions, minimum eccentricity, design procedure of short column for axial load, combined axial load and uni-axial/biaxial bending using interaction curves. (SP 16)

Introduction to footing and its types, Design of isolated column footing for axial load and combined axial load with uni-axial bending.

LEARNING RESOURCES

Text books

1. Illustrated Reinforced Concrete Design, Dr. V. L. Shah and Dr. S. R. Karve, Structures Publications, Pune.
2. Limit State Design of Reinforced Concrete, P. C. Varghese, PHI, New Delhi.

Reference books

1. Illustrated Design of Reinforced Concrete Buildings (G+3), Dr. V. L. Shah and Dr. S. R. Karve, Structures Publications, Pune.
2. RCC Analysis and Design, Sinha and Roy, S. Chand and Co. New Delhi.
3. Design of Reinforced Concrete Structures, N. Subramanian, Oxford University Press.
4. Limit State Analysis and Design, P. Dayaratnram, Wheeler Publishing Company.
5. Comprehensive Design of R.C. Structures, Punmia, Jain and Jain, Standard Book House, New Delhi.
6. Reinforced Concrete Design, S. U. Pillai and D. Menon, Tata McGraw Hill, Delhi.
7. Design of Reinforced Concrete Structures, by M. L. Gambhir, PHI, New Delhi.

IS Codes:

1. IS 456-2000: Plain and reinforced concrete-code of practice, Bureau of Indian Standards, New Delhi
2. IS 13920-2016: Ductile design and detailing of reinforced concrete structures subjected to seismic forces - code of practice, Bureau of Indian Standards, New Delhi
3. IS 875-Part 1-1987: Code of practice for design loads (other than earthquake) for buildings and structures: Part (I) dead loads-unit weights of building materials and stored materials, Bureau of Indian Standards, New Delhi
4. IS 875-Part 2-1987: Code of practice for design loads (other than earthquake) for buildings and structures: Part (II) imposed loads, Bureau of Indian Standards, New Delhi

Links to online SWAYAM/NPTEL Courses

1. STAAD.Pro Manual - https://sl1nk.com/11c08kz

YouTube/Video Links

1. **STAAD.Pro Playlist https://youtu.be/9eQYosaEttE?si=5k0dgtYw2IkdaXAY**

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PCC352-CVL **Course: Water Supply and Sanitation Engineering**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Perquisites, if any: Concepts of Engineering Sciences and Mathematics.

Course Objectives:

1. To explain the fundamentals of water supply systems, including quantity and quality requirements.
2. To describe the principles and operations of water treatment processes such as aeration and sedimentation. Designing water treatment plants including coagulation, flocculation, and filtration.
3. To know the Water distribution systems, and sanitation infrastructure
4. To know the wastewater collection, quantification, characteristics, and stream self-purification processes. To learn the preliminary and primary wastewater treatment processes and the design of related units.
5. To know the secondary treatment of sewage.

Course outcomes

On completion of the course, students will be able to:

1. Students can understand water supply infrastructure, demand estimation, and quality standards
2. Students can learn the water treatment principles and the design of basic treatment units.
3. Students can understand the water distribution systems for efficient water management.
4. Student can understand wastewater collection, quantification, characteristics, and stream self-purification processes. Understand preliminary and primary treatment units
5. Student can learn the secondary treatment of sewage.

COURSE CONTENTS

Unit 1	Basics of Water Supply Engineering	(09 hours)

Introduction to water supply scheme: importance of water infra-structure in India, data collection required for implementing water supply schemes, components and layouts. Design periods, factors affecting design periods. Quantity: rate of water consumption for various purposes, fire demand, factors affecting rate of demand, population forecasting. Quality: physical, chemical, radioactivity and bacteriological characteristics, heavy metals. Standards as per IS 10500-2012. Government of India initiatives - SMART city, AMRUT, Jal Jeevan Mission and its implication in rural India. Sanitation infrastructure: Its need, importance of sanitation infrastructure.

Unit 2	Water Treatment	(09 hours)

Water treatment: principles of water treatment operations and processes, Aeration: principle and concept, necessity, methods, removal of taste and odour, design of aeration fountain. Sedimentation: plain and chemical assisted, principle, efficiency of an ideal settling basin, types of sedimentation, settling velocity, types of sedimentation tanks, design of plain sedimentation tank, introduction and design of tube settlers. Coagulation and flocculation: necessity of coagulation, principle of coagulation, common coagulants alum and ferric salts. Filtration, mechanism of rapid sand filter and its working. Working and cleaning of filters, operational troubles. Disinfection: mechanism, factors affecting disinfection, types of disinfectants, types and methods of chlorination, break point chlorination, bleaching powder estimation.

Unit 3	**Water distribution System and Sanitation Infrastructure**	**(09 hours)**

Water distribution system: system of water supply: continuous and intermittent system different distribution systems and their components, ESR: design of ESR capacity, wastage and leakage of water: detection and prevention.
Sanitation infrastructure and wastewater quantification: wastewater, sources and types, importance of sanitation infrastructure, wastewater collection and conveyance, quantitative estimation of wastewater, sewage, storm water, self-cleansing velocity and non-scouring velocity in sanitary sewer, hydraulic design of circular sanitary sewer, necessity and location of pumping station.

Unit 4	**Sewage Treatment**	**(09 hours)**

Wastewater characteristics: Methods of sampling, treatability index, effluent discharge standards as per CPCB norms. Self-purification of natural streams: oxygen sag curve, Streeter - Phelps equation and terminology (without derivation and numerical). Preliminary, primary, sewage/effluent treatment plant - flow diagram, unit operation and process, preliminary and primary treatment, screens: types, hydraulics, velocity and head loss, design of screens, disposal of screenings. Grit chamber: sources of grit, importance of grit chamber, Primary sedimentation tank: types of settling, types of sedimentation tanks, assumptions, efficiency, factors affecting efficiency, design of primary sedimentation tank.

Unit 5	**Secondary Treatment of Sewage**	**(09 hours)**

Aerobic secondary treatment: unit operations and processes for principle of biological treatment. Activated sludge process (ASP): Conventional plug flow ASP, biochemical reactions, hydraulic and organic loading, F/M ratio, mean cell residence time, aeration method, oxygen requirement, assumptions, design of ASP, sludge volume index, sludge recycle and rate of return sludge, operational problems and maintenance in ASP, modifications in ASP. Sequencing batch reactor (SBR). **Attach growth:** Trickling filter: principle, different TF media & their characteristics, standard rate and high-rate filters, single stage & two stage filters, design using NRC formula, recirculation, ventilation, under drain system, operational problems, control measures Suspended growth system.

LEARNING RESOURCES

Text books

1. Water Supply Engineering, S. K. Garg, Khanna Publishers, New Delhi, 35th Edition (2015).
2. Water Supply and Sanitary Engineering, G. S. Birdie and J. S. Birdie, Dhanpat Rai Publishing Company, New Delhi, 9th Edition, (2010).
3. Environmental Engineering-1: Water Supply Engineering, B. C. Punmia, Ashok Jain and Arun Jain. Laxmi Publications (P) Ltd, 2nd Edition, Reprint (2016).
4. Manual on Sewerage & Sewage Treatment published by Ministry of Urban Development, New Delhi, Third Edition.
5. Waste Water Treatment & Disposal, Metcalf & Eddy, McGraw Hill Education (India) Private Limited

Reference books

1. Environmental Engineering, Peavy and Rowe, McGraw Hill Publications, (2017).
2. Optimal Design of Water Distribution Networks, P. R. Bhave, Narosa Publishing House.
3. Standard Methods for examination of water and wastewater, Mary Franson, American Public Health Association IS Codes 01
4. IS 3025: 2013, Methods of Sampling and Test (Physical, Chemical and Biological) for Water and Waste Water, Bureau of Indian Standards, New Delhi
5. Environmental Engineering, Peavy Rowe, McGraw Hill Education (India) Private Limited.
6. Wastewater Treatment for Pollution Control and Reuse, Arceivala and Asolekar, McGraw Hill Education (India) Private Limited.
7. Industrial Wastewater Treatment, A. D. Patwardhan, Eastern Economy Edition, PHI Learning Private Limited.
8. Sewage Disposal & Air Pollution Engineering, S. K. Garg, Khanna Publication.
9. Standard Methods for examination of water and wastewater, Mary Franson, American Public Health Association.
10. IS 3025: 2013, Methods of Sampling and Test (Physical, Chemical and Biological) for Water and Waste Water, Bureau of Indian Standards, New Delhi.

e-Books

1. http://cpheeo.gov.in/cms/manual-on-sewerage-and-sewage-treatment.php
2. http://cpheeo.gov.in/cms/manual-on-storm-water-drainage-systems---2019.php
3. http://cpcb.nic .in
4. http://moef.nic .in

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PCC353-CVL **Course: Design of Reinforced Concrete Structures Lab**

Teaching scheme	Credit	Examination	
Practical: 4 hours / week	02	TW OR	25 marks 25 marks

Perquisites: Fundamentals of Concrete Technology, Engineering Mechanics, Mechanics of Materials and Structural Analysis.

Course Objectives:

1. To develop practical skills in analysis, design, detailing, and drafting of reinforced concrete structures using manual methods and software tools such as AutoCAD and STAAD.Pro.
2. To provide exposure to real construction practices, bar bending schedules, and structural behavior through project work and site visits.

Course outcomes

On completion of the course, students will be able to:

1. Students will be able to model, analyze, design, and prepare detailed drawings and bar bending schedules for reinforced concrete residential buildings.
2. Students will be able to use structural design software and interpret practical construction practices through technical reports and site visits.

LIST OF PRACTICALS

COMPUTER AIDED DESIGN OF REINFORCED CONCRETE STRUCTURES (LAB)

The Term work shall consist of following design, drawing and site visit report.
Oral examination based on term work.

Part 1. Residential G+1 storey building

1. Forming groups of 4-5 students in each batch and choose a specific Residential RC structure (G+1) with isolated footing to design. Building covering all types of slabs, beams, columns, footings and staircase. Minimum plan area of each floor shall be more than 150 m^2.

2. Prepare a detailed drawing of the structure using AutoCAD.

3. Design structural elements of RC structure. (Footing, Column, Beam, slab etc.)

4. Prepare a detailed bar bending schedule for all structural elements.

5. Prepare a detailed report of the project.

Part 2. Residential G+1 Storey Building Design Using STAAD.Pro

1. Forming groups of 4-5 students in each batch and choose a specific Residential RC structure (G+1) with isolated footing to design. Building covering all types of slabs, beams, columns, footings and staircase. Minimum plan area of each floor shall be more than 150 m^2.

2. Create a 3D structural model of the building using STAAD.Pro, defining appropriate materials, supports, and load cases.

3. Analyze and design RC structural elements such as footings, columns, beams, and slabs using STAAD.Pro as per relevant design codes.

4. Generate and compile a detailed bar bending schedule for all structural elements based on the analysis and design output.

5. Prepare a comprehensive project report including modeling steps, design results, bar bending schedule, and conclusions.

Part 3 Site Visit - One is for substructure and one is for superstructure (Building under construction)

Note: For term work, the group size should not be more than five students and each group should have different design data.

LEARNING RESOURCES

Text books

1. Illustrated Reinforced Concrete Design, Dr. V. L. Shah and Dr. S. R. Karve, Structures Publications, Pune.
2. Limit State Design of Reinforced Concrete, P. C. Varghese, PHI, New Delhi.

Reference books

1. Illustrated Design of Reinforced Concrete Buildings (G+3), Dr. V. L. Shah and Dr. S. R. Karve, Structures Publications, Pune.
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IS Codes:

1. IS 456-2000: Plain and reinforced concrete-code of practice, Bureau of Indian Standards, New Delhi
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3. IS 875-Part 1-1987: Code of practice for design loads (other than earthquake) for buildings and structures: Part (I) dead loads-unit weights of building materials and stored materials, Bureau of Indian Standards, New Delhi
4. IS 875-Part 2-1987: Code of practice for design loads (other than earthquake) for buildings and structures: Part (II) imposed loads, Bureau of Indian Standards, New Delhi

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YouTube/Video Links

1. **STAAD.Pro Playlist https://youtu.be/9eQYosaEttE?si=5k0dgtYw2IkdaXAY**

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PCC354-CVL **Course: Water Supply and Sanitation Engineering Lab**

Teaching scheme	Credit	Examination	
Practical: 4 hours / week	02	OR TW	25 marks 25 marks

Perquisites, if any: Concepts of Engineering Sciences and Mathematics.

Course Objectives:

1. To develop practical knowledge of water and wastewater quality analysis through laboratory experiments and field visits.
2. To provide exposure to the design and operation of water and wastewater treatment systems using software tools and case studies.

Course outcomes

On completion of the course, students will be able to:

1. Students will be able to perform physical, chemical, and biological analysis of water and wastewater samples.
2. Students will be able to understand the functioning, design, and operational aspects of WTP, STP, and ETP systems through software applications and site visits.

LIST OF PRATICALS

Term work consists of a journal containing the following experiments (Any-8), One visit from No. 9 & 10 is mandatory, assignments, and site visit report. The practical examination will be based on the term work.

1. Determination of pH and Alkalinity of raw water and other samples such as prepared sample, soft drinks and tea etc.
2. Determination of total hardness and its components in raw water.
3. Determination of chlorides in water
4. Determination of chlorine demand and residual chlorine.
5. Determination of turbidity and optimum dose of alum.
6. Determination of dissolved oxygen in a given water and wastewater sample
7. Determination of Bio-Chemical Oxygen Demand in a given wastewater sample
8. Determination of Chemical Oxygen Demand in a given wastewater sample
9. Site visit to a water treatment plant & prepare its detailed report
10. Visit to domestic / Industrial wastewater treatment plant & prepare its detailed report

Assignments

1. Brief report on sewer materials, choice of materials, testing of sewer pipes, sewer appurtenances.
2. Brief report on a case study of package wastewater treatment plant
3. Complete design of WTP using appropriate software/Program/excel

OR Computer aided design of STP using appropriate software / Program / excel

OR Effluent Treatment Plant (ETP) of Sugar / Dairy / Distillery Industry using suitable software (e.g., ASIM, STOAT) or excel sheets etc.

LEARNING RESOURCES

Text books

1. Water Supply Engineering, S. K. Garg, Khanna Publishers, New Delhi, 35th Edition (2015).
2. Water Supply and Sanitary Engineering, G. S. Birdie and J. S. Birdie, Dhanpat Rai Publishing Company, New Delhi, 9th Edition, (2010).
3. Environmental Engineering-1: Water Supply Engineering, B. C. Punmia, Ashok Jain and Arun Jain. Laxmi Publications (P) Ltd, 2nd Edition, Reprint (2016).
4. Manual on Sewerage & Sewage Treatment published by Ministry of Urban Development, New Delhi, Third Edition.
5. Waste Water Treatment & Disposal, Metcalf & Eddy, McGraw Hill Education (India) Private Limited

Reference books

1. Environmental Engineering, Peavy and Rowe, McGraw Hill Publications, (2017).
2. Optimal Design of Water Distribution Networks, P. R. Bhave, Narosa Publishing House.
3. Standard Methods for examination of water and wastewater, Mary Franson, American Public Health Association IS Codes 01
4. IS 3025: 2013, Methods of Sampling and Test (Physical, Chemical and Biological) for Water and Waste Water, Bureau of Indian Standards, New Delhi
5. Environmental Engineering, Peavy Rowe, McGraw Hill Education (India) Private Limited.
6. Wastewater Treatment for Pollution Control and Reuse, Arceivala and Asolekar, McGraw Hill Education (India) Private Limited.
7. Industrial Wastewater Treatment, A. D. Patwardhan, Eastern Economy Edition, PHI Learning Private Limited.
8. Sewage Disposal & Air Pollution Engineering, S. K. Garg, Khanna Publication.
9. Standard Methods for examination of water and wastewater, Mary Franson, American Public Health Association.
10. IS 3025: 2013, Methods of Sampling and Test (Physical, Chemical and Biological) for Water and Waste Water, Bureau of Indian Standards, New Delhi.

e-Books

1. http://cpheeo.gov.in/cms/manual-on-sewerage-and-sewage-treatment.php
2. http://cpheeo.gov.in/cms/manual-on-storm-water-drainage-systems---2019.php
3. http://cpcb.nic .in
4. http://moef.nic .in

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PEC361A-CVL **Course: Hydrology and Water Resource Engineering**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Perquisites, if any: The basic knowledge of Fluid Mechanics

Course Objectives:

1. To introduce the fundamental concepts of hydrology, hydrological cycle, precipitation, and related processes involved in water movement in nature.
2. To develop an understanding of runoff generation, hydrograph analysis, flood estimation, stream gauging, and watershed.
3. To impart knowledge of reservoir planning, storage estimation, sedimentation, and economic aspects of water resources projects.
4. To familiarize students with groundwater occurrence, aquifer characteristics, well hydraulics, drainage, and water management practices.
5. To enable students to understand irrigation systems, crop water requirements, water distribution networks, and efficient utilization of water resources in agriculture.

Course outcomes

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

1. Analyze precipitation data and evaluate various hydrological processes affecting water availability.
2. Estimate runoff, develop hydrographs, and apply flood analysis and routing techniques for watershed management.
3. Determine reservoir capacity and evaluate reservoir planning, operation, and economic aspects of water resources projects.
4. Analyze groundwater movement, well hydraulics, drainage systems, and water management practices.
5. Estimate crop water requirements and evaluate irrigation methods and water distribution systems for efficient agricultural water use.

COURSE CONTENTS

Unit 1	Introduction to Hydrology and Precipitation	(09 hours)

Hydrological cycle and applications, Government organizations (IMD, NIH, CWC, CWPRS), Types and measurement of precipitation, Rain gauge network, Rainfall data analysis, Mean areal precipitation methods, DAD analysis, Frequency analysis, Evaporation, transpiration, evapotranspiration, Infiltration and infiltration indices

Unit 2	Runoff, Hydrographs and Flood Hydrology	(09 hours)

Factors affecting runoff, Rainfall-runoff relationships, Runoff estimation methods, Hydrographs and components, Base flow separation, Effective rainfall, Unit hydrograph and S-curve hydrograph, Synthetic hydrograph, Stream gauging techniques, Discharge Measurement by velocity-area method, Flood estimation, Rational formula, Flood frequency analysis, Design floods, Hydrologic flood routing (Muskingum method)

Unit 3	Reservoir Planning and Management	(09 hours)

Reservoir planning concepts, Reservoir investigations, Mass curve and demand curve analysis, Reservoir capacity determination, Elevation-capacity relationships, Dependable yield, Reservoir losses, Reservoir sedimentation, Density currents, Trap efficiency, Useful life of reservoir, Reservoir economics and cost apportionment methods

Unit 4	**Ground Water Hydrology and Water Management**	**(09 hours)**

Occurrence and movement of groundwater, Aquifers and specific yield, Darcy's law Safe yield, Hydraulics of wells, Tube wells and open wells, Water logging, Drainage and reclamation, Saline and alkaline lands, Warabandi, Rotational water supply, Participatory irrigation management, Cooperative water distribution systems

Unit 5	**Irrigation Engineering and Distribution Systems**	**(09 hours)**

Irrigation concepts and necessity, Methods of irrigation, Surface, subsurface and micro- irrigation, Soil-water-crop relationship, Consumptive use, Crop water requirement, Crop planning, Duty, Delta and Irrigation efficiencies, Canal and reservoir capacities, Piped Distribution Network (PDN), Advantages and applications of PDN, Canal revenue, assessment methods

LEARNING RESOURCES

Text books

1. Engineering Hydrology, K. Subramanyam, Tata McGraw Hill.
2. Hydrology and Water Resources Engineering, Vol-1, S. K. Garg, Khanna Publishers, New Delhi
3. Irrigation Engineering & Hydraulic Structures, Vol-2, S. K. Garg, Khanna Publishers, New Delhi

Reference books

1. A Textbook of Hydrology, Dr. P. Jaya Rami Reddy, USP Publisher.
2. Irrigation, Water Resources and Water Power Engineering, P. N. Modi, Standard Book House.
3. Irrigation and Water power Engineering, Dr. Punmia and Dr. Pande, Standard Publisher
4. Irrigation Engineering, Bharat Singh, Nem Chand & Bros., India
5. Irrigation Engineering, H. M. Raghunath, Wiley
6. Q-GIS for Hydrological Applications: Recipes for Catchment Hydrology and Water Management, Hans Van Der Kwast, Kurt Menke-Locate Press

Links to online SWAYAM/ NPTEL Courses

1 https://onlinecourses.nptel.ac.in/e-learning/preview/noc24_ce10

YouTube/Video Links

1. NPTEL Hydrology Course
2. NPTEL Water Resources Engineering
3. NPTEL Water Resources Engineering Videos
4. IIT Kharagpur Water Resources Lectures
5. Groundwater Hydrology Lectures (NPTEL)
6. Irrigation Engineering NPTEL Videos
7. Irrigation Engineering NPTEL Videos
8. QGIS Training Manual

Savitribai Phule Pune University
(Civil Engineering) 2024 Pattern

Course code: PEC361B-CVL **Course: Structural Audit and Retrofitting of Structures**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Perquisites, if any: Engineering Physics, Engineering Mathematics and Engineering Mechanics

Course Objectives:

01 To introduce Structural Audit: its necessity, procedure involved and report writing.
02 To introduce Retrofitting of structures: its necessity, materials & methods for retrofitting, retrofitting of RC, Steel & Masonry structures.
03 To make learners enable to design of retrofitting for RC beams and columns using FRP.

Course outcomes

On completion of the course, students will be able to:
01 Identify causes of deterioration in RC and steel structures.
02 Explore entire process of structural audit.
03 Explore necessity and methods of structural health monitoring.
04 Explain method of retrofitting for RC, steel and historical structures.
05 Design retrofitting using FRP for RC column.

COURSE CONTENTS

Unit 1	Introduction	(09 hours)

Causes of structural damages: mechanical actions, chemical attacks, earthquake, fire, damage to steel structures due to corrosion, damage to RC structures due to corrosion: corrosion induced by carbonation of concrete, chloride induced corrosion and corrosion induced by leaching of concrete.
Introduction to structural audit, its necessity, introduction to retrofitting of structures, its necessity, repairs, difference between repairs and retrofitting

Unit 2	Structural Audit	(09 hours)

Structural audit, assessment of health of structure, study of structural drawings, visual observations, nature of distress, collapse and investigation, limitations on investigator, tools for investigation, various NDT methods for assessing strength of distressed materials, concrete endoscopy. Investigation management, review of assimilated information, interviews and statements, evaluation and reporting, presentation of report, role of client, architect, consulting engineer and contractor

Unit 3	Structural Health Monitoring (SHM)	(09 hours)

Introduction to SHM, Local and Global techniques for SHM, short and long-term monitoring, active and passive monitoring, remote and wireless SHM Techniques. Instrumentation, data acquisition, data processing for SHM, Artificial Intelligence in SHM.

Unit 4	Retrofitting of Structures	(09 hours)

Methods of retrofitting: moisture barrier systems, mass reduction technique, jacketing, shortcreting, Ferro cement mesh, inserting new member, base isolation. Suitability of various retrofitting techniques for RC structures, steel structures and masonry structures and introduction to retrofitting of Historical Structures.

Unit 5	FRP and Retrofitting of RC Columns and RC Beams	(09 hours)

Fiber Reinforced Polymer (FRP), Types of FRP and their properties, advantages of FRP retrofitting, FRP retrofitting using FRP plates, FRP wrapping, FRP bars, National and International code provisions. Retrofitting of RC columns using FRP for axial confinement as per provisions of ACI 440.
Analysis and design of RC beam using FRP, Retrofitting of RC Beams using FRP for flexural strengthening, shear strengthening, Provisions of ACI 440.

LEARNING RESOURCES

Text books

01 Concrete Repair and Maintenance, P. H. Emmons and G M Sabnis, Galgotia Publication.
02 Repairs and Rehabilitation, Compilation from Indian Concrete Journals
03 Building: Structural Audit, Repairs and Restoration, Arun Kelkar, Majestic Publishing House.
04 Concrete Building Pathology, Susan Macdonald, Blackwell Publishing
05 Diagnosis and treatment of structures in Distress, R. N. Raikar, R & D Centre, (SDCPL).
06 A Handy Guide to Repairs, Rehabilitation and Waterproofing of RCC Building (Structures), Jayakumar J. Shah.

Reference books

01 ACI 440.2R-08, Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures, American Concrete Institute.
02 Xilin lu (2010), Retrofitting Design of Building Structures, Science Press, New York.
03 Strengthening and Rehabilitation of Civil Infrastructures Using Fibre-Reinforced Polymer (FRP) Composites, L. C. Hollaway and J. G. Teng, Woodhead Publishing Series in Civil and Structural Engineering
04 Maintenance, Repair & Rehabilitation & Minor Works of Building, by P C Varghese, PHI
05 Management of Deteriorating Concrete Structures, George Somerville, Taylor and Francis, Publication.
06 Durability of Cement and Cement Composites, C. L. Page, M M Page, Wood Head, Publishing.

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PEC361C-CVL **Course: Foundation Engineering**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Perquisites, if any: The basic knowledge of Engineering Mathematic, Physics.

Course Objectives:

1. To introduce the fundamental concepts of subsurface exploration and enable students to select appropriate investigation methods for foundation design.
2. To develop an understanding of geotechnical design principles for shallow foundations and well foundations under different soil conditions.
3. To impart knowledge of soil behavior under loading, focusing on estimation of immediate and consolidation settlements of foundations.
4. To familiarize students with different types of deep foundation systems such as piers, caissons, and well foundations, including their components and construction techniques.
5. To enable students to analyze and design pile foundations, including determination of load carrying capacity of single piles and pile groups.

Course outcomes

On completion of the course, students will be able to:

1. Perform subsurface investigations for foundations using different methods.
2. Understand the steps in geotechnical design of shallow foundations and well foundations.
3. Calculate immediate and primary consolidation settlement of shallow foundations.
4. Classify the types, components, and construction methods of piers, caissons, and well foundations
5. Decide the capacity of a pile and pile group.

COURSE CONTENTS

Unit 1	Subsurface Investigations for Foundations	(09 hours)

Purpose and planning of subsurface exploration, methods of Investigation: trial pits, borings, depth & number of exploration holes, core recovery, RQD, core log, geophysical methods: seismic refraction and electrical resistivity method, disturbed and undisturbed sampling, types of samplers, degree of disturbance of a sampler, field tests- SPT, N value correction and significance, DCPT, SCPT and introduction of advanced testing techniques like pressure meter test, borelog, contents of sample soil investigation report.

Unit 2	Bearing Capacity	(09 hours)

Basic definitions, modes of shear failure, bearing capacity analysis- Terzaghi's, Hanson's, Meyerhof's, Skempton's, Vesics equations and IS code method - rectangular and circular footings, bearing capacity evaluation: plate load test and SPT, Housel's perimeter shear concept, bearing capacity of layered soil, effect of water table on bearing capacity, effect of eccentricity, presumptive bearing capacity.

Unit 3	Immediate and Consolidation Settlement	(09 hours)

Immediate Settlement: introduction, causes of settlement, pressure bulb, contact pressure, significant depth of foundation, allowable settlement, differential settlement - I. S. criteria, components of settlement, use of plate load test and SPT in settlement analysis and allowable soil pressure.

Consolidation Settlement: introduction, spring analogy, Terzaghi's consolidation theory, laboratory consolidation test, determination of coefficient of consolidation- square root of time fitting method and logarithm of time fitting method, time factor, rate of settlement and its applications in shallow foundations, introduction of normal consolidation, over consolidation and pre consolidation pressure.

Unit 4	**Pile Foundations**	**(09 hours)**

Introduction: pile classification according to different criteria, pile installation - Cast in-situ, driven and bored pile, load carrying capacity of pile by static method, dynamic Methods: Engineering news formula, modified ENR formula and modified Hiley formula, pile load test and cyclic pile load test, group action: field rule, rigid block method, negative skin friction, settlement of pile group in cohesive soil by approximate method, uplift capacity of piles, micro piles.

Unit 5	**Piers and Caissons**	**(09 hours)**

Piers and Caissons: definitions, types and uses, well foundation: components, sand island method, shapes of wells, tilts and shifts: precautionary and remedial measures, bearing capacity and depth of well foundation, forces acting on well foundations, lateral stability of well foundation – Terzaghi's method, IRC method, ultimate soil resistance method (only numerical on lateral stability analysis, no derivation for methods).

LEARNING RESOURCES

Text books

1. Foundation Engineering by P. C. Varghese, PHI Learning Pvt. Ltd.
2. Soil Mechanics and Foundation Engineering by A. K. Arora, Standard Publishers.
3. Soil Mechanics and Foundation Engineering by V. N. S Murthy, Marcel Dekker, Inc. New York.
4. Soil Mechanics and Foundation Engineering by B. C. Punmia, Laxmi Publications Delhi.

Reference books

1 Basic and Applied Soil Mechanics by Gopal Ranjan and A. S. Rao, New Age International Publishers.
2 Principles of Foundation Engineering, Braja M. Das, PWS Publishing Company.
3 Geotechnical Engineering by Shashi K. Gulati & Manoj Datta, Tata McGraw Hill.
4 Foundation Analysis and Design, J. E. Bowels, McGraw-Hill.

Links to online SWAYAM / NPTEL Courses

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ce39
2. https://nptel.ac.in/courses/105105176
3. https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ce33

YouTube/Video Links

1. https://youtu.be/J-Bdzgg7pqA?si=8jyLZ5xx5oyRKBJG
2. https://youtu.be/A_7r-QF1nCs?si=m44xZl6h6b1pgUeN
3. https://youtu.be/hGuZ4L6ofp8?si=wKNCExid5xhKLz5v
4. https://youtu.be/rTJp4KRIgWM?si=py3lHEq4Ht119zWj
5. https://youtu.be/i_107DxLHvE?si=u3CMFxSO2tstMFmO

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PEC361D-CVL **Course: Construction Chemicals and Water Proofing**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Perquisites, if any: Basic Knowledge of Concrete Technology. Building Materials

Course Objectives:

1. To introduce the fundamentals, importance, and applications of waterproofing in civil engineering structures.
2. To develop understanding of waterproofing materials, admixtures, fibers, and polymer modified systems used in construction.
3. To study advanced coatings, linings, and hi-tech waterproofing systems for structural protection and durability.
4. To familiarize students with conventional and modern waterproofing techniques used in buildings and water retaining structures.
5. To analyze practical case studies related to waterproofing failures, remedial measures, and maintenance practices.

Course outcomes

On completion of the course, students will be able to:

1. Understand the importance, applications, and treatment methods of waterproofing for various civil engineering structures and building components.
2. Identify and select suitable waterproofing materials, fibers, admixtures, and polymer modified systems for construction applications.
3. Apply knowledge of protective coatings and linings for waterproofing, corrosion resistance, and surface protection in structures.
4. Analyze conventional and advanced waterproofing techniques, grouting methods, and protective systems for buildings and water retaining structures.
5. Evaluate practical waterproofing problems through case studies and recommend suitable remedial and maintenance measures for durable structures.

COURSE CONTENTS

Unit 1	Basics of Water Proofing	(09 hours)

Introduction, importance, need, and applications of waterproofing in civil engineering structures. Waterproofing treatments for basements, podiums, terraces, bathrooms, balconies, toilets, overhead and underground water tanks, lift areas, vertical walls, and below tile applications. Expansion joint treatment, various sealants, selection of waterproofing materials, maintenance, and remedial measures for leakage control.

Unit 2	Basics of Waterproofing Materials	(09 hours)

Introduction to cement and its types including OPC, PPC, GGBS, and Micro Silica. Fine and coarse aggregates and their types based on applications, secondary reinforcement fibers used in concrete such as polyester, polypropylene, carbon, aramid, and glass fibers, and geotextiles. Admixtures and polymer modified cementitious (PMC) systems including PVA, SBR latex, acrylics, water-based epoxy, and polyurethane dispersion (PUD) systems with their properties and applications.

Unit 3	Special Hi-Tech Coatings & Linings	(09 hours)

Introduction to protective coatings and linings used in construction, classification based on thickness as coatings (up to 500 microns) and linings (greater than 500 microns). Study of chlorinated rubber paints, polyurethane coatings, epoxy coatings, polyurea coatings and linings, polysulfide systems, and silane-siloxane water repellent coatings including their properties, applications, and performance in waterproofing and surface protection.

Unit 4	**Introduction to Conventional and Modern Water Proofing Techniques**	**(09 hours)**

Conventional waterproofing practices including brick bat coba and box type waterproofing systems. Use of hi-tech polymers, various grouting methods, and expansion joint sealing requirements for high-rise buildings. Waterproofing techniques for dams, canals, aqueducts, overhead tanks, underground tanks, and RCC water retaining structures. Introduction to pipeline treatment and protective systems for durability and leakage prevention.

Unit 5	**Case studies on Waterproofing**	**(09 hours)**

Case studies on waterproofing systems and remedial treatments for high-rise buildings, industrial buildings, school buildings, overhead tanks (OHT), underground tanks (UGT), aqueducts, dams, canals, and basement waterproofing including CIRUS Reactor structures, with emphasis on practical problems, failure analysis, and maintenance practices.

LEARNING RESOURCES

Text books

1. handbook on waterproofing of Concrete Structures by the Indian Concrete Institute
2. Methodology of Waterproofing of Concrete Structures by Ranjit Mohan Chackraburtty

Savitribai Phule Pune University
(Civil Engineering) 2024 Pattern

Course code: PEC362A-CVL **Course: Soft Computing Techniques**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Perquisites, if any:

Course Objectives:

1. Understand the fundamental concepts of numerical methods and their applications in solving Civil Engineering problems.
2. Apply numerical techniques for solving nonlinear equations, numerical integration, and systems of linear equations.
3. Understand optimization techniques and iterative methods used in engineering computations and problem-solving.
4. Analyze engineering data using statistical methods, probability distributions, and hypothesis testing techniques.
5. Develop predictive and analytical models using correlation, regression, interpolation, and curve-fitting techniques for engineering applications

Course outcomes:

On completion of the course, students will be able to:

1. Apply numerical methods such as Bisection, False Position, Newton-Raphson, and Secant methods for solving nonlinear engineering equations
2. Apply numerical integration techniques including Trapezoidal Rule, Simpson's Rules, and Gauss Quadrature methods for engineering computations.
3. Solve systems of linear equations using direct and iterative numerical methods and apply optimization concepts to engineering problems.
4. Analyze engineering data using statistical methods, probability distributions, sampling techniques, and hypothesis testing.
5. Develop and interpret predictive models using correlation, regression, interpolation, extrapolation, and curve fitting techniques for engineering applications.

COURSE CONTENTS

Unit 1	Numerical Methods for Nonlinear Engineering Problems	(09 hours)

Introduction to numerical methods and engineering applications, errors and accuracy in numerical computations, Bisection method, False Position method, Newton-Raphson method, Secant method, comparison of numerical methods, applications to Civil Engineering problems.

Unit 2	Numerical Integration Techniques	(09 hours)

Need and scope of numerical integration in engineering analysis, Trapezoidal rule, Simpson's 1/3rd rule, Simpson's 3/8th rule, Gauss Quadrature method, accuracy and error estimation, applications in area, volume, and structural computations.

Unit 3	Optimization and Numerical Solution of Linear Equations	(09 hours)

Introduction to optimization techniques and Civil Engineering applications, formulation of optimization problems, direct solution methods: Gauss Elimination and Gauss Jordan methods, iterative solution methods: Gauss Seidel method, and engineering applications.

Unit 4	**Statistical Methods and Probability Distributions**	**(09 hours)**

Introduction to statistical analysis, collection, classification, and graphical representation of engineering data, measures of central tendency and dispersion, sampling techniques, probability concepts, Binomial, Poisson, and Normal distributions, hypothesis testing, chi-square test, and applications in engineering data analysis.

Unit 5	**Correlation, Regression, and Data Modeling**	**(09 hours)**

Correlation analysis and coefficient of correlation, probable error, single and multiple regression analysis, interpolation and extrapolation techniques, curve fitting methods, development of predictive models for engineering applications, and data interpretation.

LEARNING RESOURCES

Text books

1. E. Ward Cheney, David R. Kincaid, Numerical Methods and Applications, Brooks Cole / Cengage Learning India
2. S. C. Chapra & R. P. Canale, Numerical Methods for Engineering, TMH Publications
3. E. Balgurusamy, Numerical Methods, TMH Publications
4. Krishna Raju, Numerical Methods in Civil Engineering, CBS

Reference books

1. Statistical methods – S.P.Gupta.
2. Probability and Statistics for Engineers – Richard A Johnson
3. Probability and Statistics for Science and Engineering – G Shankar Rao.
4. Higher Engg. Mathematics – B.S. Grewa.

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: PEC362B-CVL **Course: Solid Waste Management**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Perquisites, if any: Fundamentals of Environmental Studies, Engineering Chemistry and Water Supply and Sanitation Engineering

Course Objectives:

1. To understand problems of solid waste, estimate and characterize the solid waste and apply the knowledge of laws for municipal solid waste management for handling of MSW.
2. To understand government initiatives for management of solid waste, to apply the knowledge of mathematics, science, and engineering for effective solid waste collection systems, for waste collection route optimization and its economics.
3. To understand processing of solid waste, material recovery facility and to design composting systems, maintain and operate composting process for effective organic waste recycling.
4. To understand working of waste to energy system and to design of bio-methnation and incineration system.
5. To design & manage construction and operations of landfill facilities and management of legacy solid waste.

Course outcomes

On completion of the course, students will be able to:

1. Outline solid waste management systems with respect to its generation rate (quantity), sampling, characteristics and regulatory/legal requirements.
2. Explain and suggest relevant method of storage, collection and transportation of solid waste for the given site condition with justification.
3. Develop understanding of technological applications for processing and material recovery from solid waste with its economics and design composting system for organic waste.
4. Describe the fundamental and technological aspects of waste to energy systems from solid waste and to design anaerobic digester and incineration system.
5. Outline the design, operation, and maintenance of sanitary landfill and management of legacy waste

COURSE CONTENTS

Unit I	Introduction to Solid Waste Management	(09 hours)

Definition, objectives of SWM, impacts of improper SWM: Soil, water and air, functional outlines of SWM, sources and types of solid waste. MSW: sampling, refuse analysis, composition, characteristics: physical, chemical, biological and generation rate, factors affecting generation rate, estimation of quantity of solid waste. Sustainable solid waste management for smart cities, role of urban local bodies in waste management, objectives and importance of MSW Rules 2016, rules and regulations of SWM in developed countries.

Unit 2	Government Initiatives, Collection & Transportation of Solid Waste	(09 hours)

Swachh survekshan and its impact on the SWM scenario in India, national urban livelihood missions (NULM) and its role in SWM, social entrepreneurship, swachhta & rural engagement cell (SESREC): Government of India initiatives, success stories of SWM in India. Integrated solid waste management, storage, different methods of collection, collection systems, transfer and transportation of solid waste, uses of radio frequency identification (RFI)/global positioning system (GPS) for tracking vehicle's location, optimization of route, measurement and methods of measuring solid waste, economics of solid waste collection and transport.

Unit 3	Processing and Transformation of Solid Waste	(09 hours)

Decentralized system vs centralized system, three tier system, source reduction, segregation and salvage, material recovery facility centers, resource recovery of bye-products, recycling and reuse of solid waste, use of solid waste as raw materials in industry, value added products, recycling and carbon credits, economics of solid waste processing, circular economy in waste management. Theory of composting, processing before composting, types of composting (home composting, vermicomposting, organic waste converter, rotary drum, continuous flow reactor), explain methods: Indore method, Bangalore method, mechanical composting plant, factors governing composting and design of composting system.

Unit 4	Waste to Energy	(09 hours)

Bio-methnation: theory of anaerobic digestion, stages, factors affecting anaerobic digestion, recovery of bio-gas, applications/use of biogas, design of anaerobic digester. Energy content of MSW, estimation of low and high heating value (LHV, HHV), theory and types of incinerators, design of incineration plant. Pyrolysis, refused derived fuel (RDF), plasma gasification: working principle, energy recovery, advantages, limitations and applications, environmental impacts of waste to energy: dioxins, furans, heavy metals etc.

Unit 5	Disposal of Solid Waste	(09 hours)

Landfill: Introduction, components of land filling, types of land filling, site selection, acceptable waste, construction techniques, maintenance and precautions, leachate and landfill gas: estimation, management, treatment and disposal/reuse, control of contamination of ground water, operation monitoring, closure and end-use, advantages and disadvantages of secured landfill facility (SLF), design of sanitary landfill, slope stability analysis, concept of bioreactor landfill: principle, types, applications. Legacy waste management or biomining: concept, methods, applications, economics and time duration.

LEARNING RESOURCES

Text books

1. Integrated Solid Waste Management: Engineering Principles and Management Issues, George Tchobanoglous, Hilary Theisen, Samuel Vigil, Tchobanoglous George, Vigil Samuel, McGraw-Hill Companies, Incorporated.
2. Solid waste management, Dr. A.D. Bhide
3. Solid Waste Management, Sasikumar K and Sanoop Gopi Krishna, PHI.

Reference books

1. Solid waste Engineering, Vesilind P. A., Worrell W and Reinhart, Thomson Learning Inc., Singapore.
2. CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000.
3. Hazardous Waste Management, Charles A. Wentz, Second Edition, McGraw Hill International Edition, New York.
4. Standard Handbook of Hazardous Waste Treatment and Disposal, Harry Freeman, McGraw-Hill Education, 1998

Savitribai Phule Pune University
(Civil Engineering) 2024 Pattern

Course code: PEC362C-CVL **Course: Advanced Structural Analysis**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Perquisites, if any: Engineering Mechanics, Mechanics of Structures

Course Objectives:

1. To formulate and analyze axially loaded bar and spring systems using the member stiffness matrix approach.
2. To develop and apply member stiffness matrices for analysis of plane truss structures.
3. To formulate and analyze beam structures using the stiffness matrix method.
4. To apply stiffness matrix method for analysis of grid structures using member and structure approaches.
5. To formulate and analyze plane and space skeletal structures using stiffness matrix method.

Course outcomes

On completion of the course, students will be able to:

1. Analyze axially loaded bar and spring systems using stiffness matrix method.
2. Analyze plane truss structures using member stiffness matrix approach.
3. Analyze beam structures using stiffness matrix method.
4. Analyze grid structures using stiffness matrix method through member and structure approaches.
5. Analyze plane frames, space trusses, and space frame structures using global stiffness matrix approach.

COURSE CONTENTS

Unit 1	Stiffness Matrix Method for Axially Loaded Bars – Member Approach	(09 hours)

Review of degrees of freedom for basic structures, basic concept of stiffness, stiffness coefficients, local and global coordinate systems. Generation of member stiffness matrix for axially loaded bar members, formation of overall stiffness matrix, and analysis of axially loaded bars and springs using member stiffness approach, limited to a maximum of three unknowns.

Unit 2	Stiffness Matrix Method for Plane Trusses – Member Approach	(09 hours)

Formation of member stiffness matrices of a truss member considering two degrees of freedom at each node, formation of overall stiffness matrix, and analysis of plane trusses by member approach involving not more than three unknowns.

Unit 3	Stiffness Matrix Method for Beams – Member Approach	(09 hours)

Generation of member stiffness matrix for beams, formation of overall stiffness matrix and load vector, and analysis of beams by member approach up to a maximum of three unknowns.

Unit 4	Analysis of Grid by Stiffness Method	(09 hours)

Stiffness matrix method using structure approach for analysis of orthogonal grid structures, limited to a maximum of three unknowns.

Member approach: generation of local member stiffness matrix for grid members, concept and derivation of transformation matrix, and formation of global stiffness matrix.

Unit 5	Stiffness Matrix Method for Plane Frame, Space Truss and Space Frame	(09 hours)

Generation of local member stiffness matrix for plane frame, formation of transformation matrix for plane frame member, concept of formation of global member stiffness matrix for plane frame member.
Generation of local member stiffness matrix, transformation matrix for space truss member, concept of formation of global member stiffness matrix.
Formation of local member stiffness matrix of space frame element.

LEARNING RESOURCES

Text books

1. Structural Analysis – A Matrix Approach – Pandit & Gupta - Tata McGraw Hill Publication.
2. Matrix Methods of Structural Analysis – Meghre & Deshmukh- Charotar Publishing House, Anand

Reference books

1. Matrix Methods of Structural Analysis- Wang, C. K., International Textbook Co., 1970.
2. Matrix Analysis of Framed Structures – Gere & Weaver- CBS Publications, Delhi.
3. Matrix & Finite Element analysis of structures – A.H. Shaikh and Madhujit Mukhopadhyay.
4. Numerical Methods for Engineering – S.C. Chapra & R.P. Canale Tata McGraw Hill Publication.

Savitribai Phule Pune University
(Civil Engineering) 2024 Pattern

Course code: PEC362D-CVL **Course: Plumbing Engineering**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Perquisites, if any: Fluid Mechanics and Hydraulics, Building Construction and Materials

Companion course, if any

Course Objectives:

After completion of the course, students will be able to:

1. To understand the basic principles, terminology, and standards used in Plumbing engineering and Public Health Engineering.
2. To study various water supply systems, plumbing pipes, fittings, fixtures, and their applications in buildings.
3. To understand sanitary systems, drainage systems, traps, vents, and sewage disposal methods used in residential and commercial buildings.
4. To learn the design considerations and layout planning of plumbing systems for low-rise and high-rise buildings.
5. To develop knowledge of sustainable plumbing practices, water conservation techniques, and relevant plumbing codes and standards.

Course outcomes

1. Explain the fundamentals of plumbing engineering, plumbing terminology, codes, standards, and coordination requirements in buildings.
2. Select suitable water supply pipes, fittings, valves, and plumbing fixtures for different building applications.
3. Design and analyze sanitary drainage systems, venting systems, traps, and building sewer arrangements.
4. Prepare basic plumbing layouts and apply design principles for water supply, sewerage, and storm water systems in buildings.
5. Apply plumbing engineering concepts for high-rise buildings while considering sustainability, water conservation, and modern plumbing practices.

COURSE CONTENTS

Unit 1	Introduction to Plumbing Engineering and Codes	6 Hours)

Definition and scope of Plumbing Engineering / Public Health Engineering, Indian plumbing industry and applications, Roles of plumbing contractor, plumber, and consultant, plumbing terminology and principles, Introduction to plumbing codes and standards, UPC-I, ITM, GPCS-I, Local plumbing laws and regulations, testing labelling, workmanship standards, Architectural and structural coordination, Plumbing shafts, Sunken slabs, Ledge walls

Unit 2	Water Supply Systems, Pipes and Fixtures	(09 hours)

Water Supply System: Types of water supply systems, Pipes and fittings: GI, Copper, Stainless Steel, HDPE, CPVC, UPVC, PPR, PEX, Jointing methods and plumbing tools, Water hammering and pipe protection, Velocity, pressure and temperature limitations, Water Supply Fixture Units (WSFU), Valves, regulators and backflow prevention, Water tanks and commissioning

Plumbing Fixtures: Water closets, urinals, bidets, Lavatory and bath fixtures, Kitchen sinks and service fixtures Water conserving fixtures and WEP-I rating, Standard fixture heights and spacing, Floor slopes and prohibited fixtures.

Unit 3	Sanitary Plumbing and Building Drainage	(09 hours)

Sanitary System: Soil, waste and grey water systems, Classification of sanitary fixtures, Indirect waste connections, Fixtures below invert level

Building Drainage: One-pipe and two-pipe systems, Vent pipes and anti-siphonage, building drainage pipes and fittings, Drainage Fixture Units (DFU), Sizing and testing of drainage system, Cleanouts and inspection chambers, Introduction to storm water drainage.

Unit 4	Traps, Vents, Sewers and Sewage Disposal	(09 hours)

Traps and Vents: Purpose and types of traps, Trap seal and protection, Trap primers and prohibited trap, Vent systems and vent sizing, Wet venting and stack venting, Vent connections and termination

Building Sewers: Pipe gradients and sewer fittings, Manholes, gully traps and chambers, Sumps and pumps, Septic tanks and sewage disposal methods, Grease, oil and sand interceptors.

Unit 5	Plumbing Design and High-Rise Plumbing	(09 hours)

High-Rise Plumbing: Definition and challenges in high-rise buildings, Hydro-pneumatic systems, Pressure reducing valves, Break pressure tanks and multiple storage tanks, Rainwater systems, Centralized hot water supply

Plumbing Design & Case Study: Plumbing drawings and layouts, Water supply design considerations, Sewer and storm water network design, CPHEEO guidelines, Case studies on plumbing systems

LEARNING RESOURCES

Text books

1. Plumbing Engineering‖ by Deolalikar.
2. Plumbing Engineering, Theory and Practice‖ by Subhsh Patil. SEEMA Publishers Mumbai
3. National Plumbing Codes Handbook‖, by R. Dodge Woodson
4. Plumbing, Sanitation and Domestic Engineering Publication: Dhanpat Rai Publications

Reference books

1. Plumbing, Sanitation and Domestic Engineering‖ Volume – 1to 4 by G. S. Williams, Mc Graw Hill.
2. Plumbing, Sanitation and Domestic Engineering, Data Sheets & Wall Charts‖ by G. S. Williams, Mc Graw Hill
3. Central Public Health and Environmental Engineering Organisation Manual (CPHEEO)‖.

Codes: 1. Uniform Plumbing Code- India (UPC-I)
2. Illustrated Training Manual (ITM)

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course Code: MDM-371CVL **Course: Geo-informatics - II**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 Marks 70 Marks

Perquisites: Basic knowledge of Surveying and Computer Fundamentals.

Companion course: Surveying, Environmental Engineering, Engineering Geology.

Course Objectives:

This course introduces Geo-informatics applications in various civil engineering domains. The objectives are:

1. To introduce basic concepts of Geo-informatics and spatial data.
2. To understand applications of Geo-informatics in water resources engineering.
3. To develop knowledge of geotechnical and geological applications using GIS and Remote Sensing.
4. To explain the use of Geo-informatics in transportation and urban planning.
5. To introduce Geo-informatics techniques in construction and infrastructure development.

Course outcomes:

On completion of the course, the students will be able to:

CO1: Explain basic concepts of Geo-informatics and its environmental applications.
CO2: Describe the use of Geo-informatics in water resources analysis such as watershed and drainage studies.
CO3: Interpret soil, rock, and land characteristics using geospatial techniques for geotechnical applications.
CO4: Explain the use of GIS in transportation planning, route analysis and urban development.
CO5: Describe the application of Geo-informatics techniques in site selection, infrastructure mapping and construction planning.

COURSE CONTENTS

Unit I	Revision of Geo-informatics & Environmental Applications	(09 hours)

Brief revision of Geo-informatics concepts including GIS, Remote Sensing, and GNSS. Applications of Geo-informatics in environmental monitoring and management. Environmental components – air, water and land. Preparation and interpretation of thematic maps for environmental analysis. Use of geospatial datasets from platforms such as Bhuvan and USGS. Spatial analysis for pollution monitoring, land degradation assessment and environmental planning. Introduction to Environmental Impact Assessment (EIA) using GIS and Remote Sensing techniques.

Case Study: Environmental monitoring using geospatial data.

Unit II	Water Resources Applications	(09 hours)

Hydrological cycle and watershed concepts. Applications of Digital Elevation Models (DEM) in hydrology. Watershed delineation and drainage analysis. Flood mapping and groundwater potential assessment using geospatial techniques. Rainfall-runoff analysis support using GIS datasets. Use of open-source DEM datasets for water resources planning and management.

Case Study: Watershed analysis and flood mapping.

Unit III	Geotechnical Engineering Applications	(09 hours)

Applications of Geo-informatics in geotechnical engineering. Soil and land use mapping for engineering purposes. Soil erosion and land degradation assessment. GIS-based landslide-prone area identification and susceptibility mapping. Terrain stability analysis and hazard zonation using geospatial techniques. Applications in site investigation and slope stability assessment.

Case Study: Landslide susceptibility mapping.

Unit IV	Transportation & Urban Engineering Applications	(09 hours)

Applications of Geo-informatics in transportation engineering and urban planning. Route alignment and route optimization studies using GIS. Traffic and transportation network analysis concepts. Land Use/Land Cover (LULC) applications in urban infrastructure planning. Applications in smart city development, traffic management and urban infrastructure monitoring.

Case Study: Urban planning and route optimization.

Unit V	Construction & Infrastructure Applications	(09 hours)

Applications of Geo-informatics in construction and infrastructure projects. Site suitability and site selection using overlay analysis. Infrastructure and utility mapping. GIS applications in project planning, monitoring and asset management. Overview of real-life civil engineering applications using Geo-informatics. Introductory exposure to GIS automation and basic Python concepts for civil engineering applications and decision support.

Case Study: Site suitability analysis for infrastructure development.

Learning Resources

Textbooks

- "Remote Sensing and GIS" – Basudeb Bhatta A comprehensive book covering GIS, remote sensing, GPS, and geospatial analysis; widely used for civil engineering and geoinformatics courses.
- "Geographic Information Systems" – Kang-Tsung Chang Covers GIS fundamentals, data models, and spatial analysis concepts.
- "Principles of Geographic Information Systems" – P.A. Burrough & R.A. McDonnell Standard reference for GIS theory and applications.

Reference Books

- "Remote Sensing and Image Interpretation" – Lillesand, Kiefer & Chipman Classic book for understanding remote sensing principles and image analysis.
- "Advances in Geoinformatics: Remote Sensing and GIS" – Bhunia et al. Covers modern techniques and applications in geoinformatics.
- "Applications of Geomatics in Civil Engineering" – J.K. Ghosh et al. Focuses on real-world civil engineering applications using geospatial technologies.
- "Application of Remote Sensing and GIS in Natural Resources and Built Infrastructure Management" – V.P. Singh et al. Useful for advanced application-based understanding.

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course Code: MDM-371CVL **Course: Geo-informatics - II Lab**

Teaching scheme	Credit	Examination	
Theory: 2 hours / week	01	TW OR	25 Marks 25 Marks

Perquisites: Basic knowledge of Surveying and Computer Fundamentals.

Companion course: Surveying, Environmental Engineering, Engineering Geology.

COURSE CONTENTS

List of Practical's

1. **Study of GIS Software Tools**
   Study of fundamental tools of GIS software (QGIS and ArcGIS) including layer handling, navigation tools, selection tools, and basic analysis functions.
2. **Data Import and Export**
   Import and export of spatial data between GIS software (QGIS/ArcGIS) and AutoCAD/Revit. Understanding file formats such as DXF, SHP, etc.
3. **Geo-referencing and Geo-tagging**
   Geo-referencing of maps using base maps/Google Earth in QGIS/ArcGIS, assigning coordinate systems and identifying ground control points.
4. **Digitization of Toposheet**
   Digitization using QGIS/ArcGIS, creation of point, line, and polygon features, and attribute data entry.
5. **Preparation of Thematic Maps**
   Generation of thematic maps such as contour map, drainage map, and road network map using QGIS/ArcGIS tools.
6. **Visual Image Interpretation**
   Interpretation of satellite images using GIS platforms (QGIS/ArcGIS) based on tone, texture, pattern, shape, and size.
7. **DEM Analysis**
   Preparation and analysis of Digital Elevation Model (DEM) using QGIS/ArcGIS, including slope and terrain analysis.
8. **GNSS Data Collection and Mapping**
   Collection of GPS/GNSS coordinates and importing into QGIS/ArcGIS for mapping and visualization.
9. **Application in Smart City Development**
   Study of GIS applications in urban planning, infrastructure mapping, and service management using QGIS/ArcGIS.
10. **Land Use / Land Cover (LULC) Classification**
    LULC classification using Remote Sensing data in QGIS/ArcGIS (basic or supervised classification).
11. **Site Suitability Analysis (Overlay Method)**
    Selection of suitable sites using overlay analysis in QGIS/ArcGIS based on parameters like land use, slope, road proximity, and drainage.
12. **Mini Project**
    Preparation of a project using real datasets (e.g., Bhuvan, USGS) using QGIS/ArcGIS such as:

- LULC Mapping
- Watershed Analysis
- Site Suitability Analysis
- Urban Planning Map

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course Code: VSE373-CVL **Course: Solar Technology and Maintenance**

Teaching scheme	Credit	Examination	
Theory: 2 hours / week	02	TW	50 Marks

Perquisites: Basic knowledge of Physics, Electrical Engineering, Basic Electronics, Semiconductor Devices, Energy Conversion, Electrical Measurements, and Renewable Energy concepts.

Course Objectives:

- To apply safe installation, wiring, testing, and commissioning practices for solar PV systems
- To analyze the impact of environmental and operational conditions on solar PV system performance.
- To evaluate maintenance and troubleshooting procedures for solar photovoltaic systems and associated equipment.
- To develop practical solutions and technical documentation for improving solar energy system efficiency and reliability.

Course outcomes:

On completion of the course, the students will be able to:

- Apply safe installation, wiring, commissioning, and performance measurement techniques for solar PV systems.
- Analyze the effect of irradiance, temperature, shading, and environmental conditions on solar PV performance.
- Evaluate maintenance procedures, inverter health, battery performance, and troubleshooting methods in solar systems.
- Create simple practical solutions or documentation for improving solar system performance via mini projects.

List of Practical's

Perform 8 experiments, Experiment No 1, 2 and 10 are compulsory. Perform any 2 Experiments from 3 to 5. Perform any 3 Experiments from 6 to 9.

1. Measurement of solar irradiance using pyrometer/lux meter at different times and tilt angles.
   Real-World Assignment: Survey solar irradiance on the college rooftop and estimate daily energy generation for a 100 W solar panel.
2. Plot I-V and P-V characteristics of solar PV module under varying light & temperature.
   Real-World Assignment: Simulate cloudy/rainy day conditions. Calculate module efficiency and estimate annual energy loss in local area climate.
3. Survey and Comparative Analysis of Solar PV Installation Systems: Grid-Tied, Hybrid, and Off-Grid Configurations.
   Real-World Assignment: Survey 2–3 real solar installations (e.g., college rooftop, nearby home/business, or online/virtual)
4. Series and parallel connection of PV modules, observe mismatch issues.
   Real-World Assignment: Design a small array for 12V/24V system (e.g., for small electrical loads). Calculate total power and suggest suitable protection.
5. Installation and wiring of standalone solar PV system (PV > Charge controller > Battery > Load/Inverter)
   Real-World Assignment: Prepare a complete wiring diagram and BOM for a 100W standalone system.
6. Preventive maintenance: Cleaning, visual inspection, corrosion/loose connection check.
   Real-World Assignment: Inspect any existing rooftop solar panel installation. Prepare a 6-month maintenance schedule with cost estimation (dust cleaning, tightening)
7. Grid-Related Maintenance Checks for Grid-Tied Solar PV Systems: Inverter Health, Performance Monitoring, and Fault Diagnosis.

Real-World Assignment: Survey a real grid-tied installation, Prepare a maintenance schedule: Monthly inverter check, quarterly visual, annual professional inspection.

8. Mounting structure assembly: Rooftop/ground mount, tilt adjustment, stability check
   Real-World Assignment: Design a simple mounting frame for local area wind load conditions. Calculate wind load and suggest material/cost for a 5kW residential installation.
9. IoT-Based Real-Time Solar PV System Monitoring and Performance Dashboard.
   Real-World Assignment: Develop a simple dashboard for real-time monitoring of solar energy generation.
10. Industrial Visit to Solar power plant/ solar installation in local area:
    Real-World Assignment: Prepare a technical report on solar PV system operation, maintenance practices, and safety measures.

Learning Resources

Textbooks

- S.P. Sukhatme, Solar Energy
- C.S. Solanki, Solar Photovoltaics
- D.P. Kothari et al., Renewable Energy Sources
- G.D. Rai, Non-Conventional Energy Sources
- H.P. Garg, Solar Energy Utilization

Reference Books

- Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers Author:
- Solar PV System: Design, Installation, Operation and Maintenance, Authors: L. Ashok Kumar and K. Mohana Sundaram.
- Solar Engineering of Thermal Processes, Photo voltaics and Wind(5^{th} Edition) Authors: JohnA. Duffie, William A. Beckman (updated with Nathan Blair).
- Principles of Solar Engineering (3rd Edition) Authors: D. Yogi Goswami, Frank Kreith, Jan F. Kreider

Links to online SWAYAM/NPTEL Courses

- Solar Photovoltaics: Fundamentals, Technology and Applications: https://onlinecourses.nptel.ac.in/noc
- Skill Cat or Other Free Solar Training (Installation Focus). https://www.skillcatapp.com/solarinstallation-training
- SWAYAM – Solar Energy and Solar PV Systems
- NPTEL – Power Electronics Applications in Renewable Energy Systems

SAVITRIBAI PHULE PUNE UNIVERSITY (SPPU), PUNE, MAHARASHTRA, INDIA

TE - CIVIL ENGINEERING

HONORS COURSE

(Students should opt same HONORS course for all semester of TE CIVIL & BE CIVIL)

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Savitribai Phule Pune University With effect from 2026-27														
HONORS in Metro Construction														
Course Code	**Course Type**	**Course Name**	**Teaching Scheme (Hrs./week)**			**Examination Scheme and Marks**					**Credits**			
			Theory	**Tutorial**	**Practical**	**CCE***	**End-Sem**	**Term -**	**Practical**	**Oral**	**Theory**	**Tutorial**	**Practical**	**Total**
Semester V														
	Programme Core Course 1	Metro Planning, Alignment and Surveying	3	-	-	30	70	-	-	-	3	0	-	3
	Programme Core Course Lab 1	Metro Planning, Alignment and Surveying Lab	-	-	4	-	-	25	-	25	-	-	2	2
Semester VI														
	Programme Core Course 2	Planning, Estimation and Project Management for Metro Construction	3	-	-	30	70	-	-	-	3	0	-	3
	Programme Core Course Lab 2	Planning, Estimation and Project Management for Metro Construction Lab	-	-	4	-	-	25	-	25	-	-	2	2
Total			**6**	**0**	**8**	**60**	**140**	**50**	**0**	**50**	**6**	**0**	**4**	**10**
			14 Hrs.			**300 Marks**					**10 Credits**			

Savitribai Phule Pune University
(Civil Engineering) 2024 Pattern

Semester V

Course code: HONORS **Course: Metro Planning, Alignment and Surveying**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Perquisites, if any: Surveying

Course Objectives:

1. Understand the evolution, planning framework, and role of urban metro systems in sustainable transportation and smart city development.
2. Apply engineering principles for planning and designing metro alignments, including route selection, geometric design, and interchange facilities.
3. Develop knowledge of modern surveying technologies and their applications in planning, design, and execution of metro infrastructure projects.
4. Understand the application of Geographic Information Systems (GIS) and Remote Sensing techniques for corridor planning, utility mapping, and infrastructure management.
5. Analyze the planning and design aspects of metro stations and depots, emphasizing operational efficiency, passenger movement, accessibility, and universal design.

Course outcomes

On completion of the course, learner will be able to:

1. Explain the concepts, components, and planning framework of urban metro systems and their contribution to sustainable urban development.
2. Select and evaluate suitable metro alignments and geometric design parameters for different urban conditions.
3. Apply advanced surveying technologies such as Total Station, DGPS, GNSS, LiDAR, drones, and mobile mapping systems for metro project planning and execution.
4. Utilize GIS and Remote Sensing tools for spatial database creation, corridor mapping, utility management, and infrastructure planning.
5. Analyze and develop planning solutions for metro stations and depots considering passenger flow, multimodal integration, accessibility, and operational requirements.

COURSE CONTENTS

Unit 1	Introduction to Urban Metro Systems	(09 hours)

Introduction to urban metro transportation systems, their evolution and development across the world and in India, characteristics and components of metro rail networks, significance of metro systems in sustainable urban mobility

and smart city development, concept and principles of Transit-Oriented Development (TOD), integration of metro systems with other modes of public transport, and the metro planning framework including demand assessment, feasibility studies, and policy considerations.

Unit 2	Metro Alignment Engineering	(09 hours)

Principles and criteria for metro route selection considering technical, economic, environmental, and social factors, planning and design of elevated, underground, and at-grade metro corridors, horizontal and vertical alignment design, geometric standards for curves and gradients, engineering considerations for safe and efficient operations, planning of interchange stations and terminal facilities, and optimization of passenger connectivity and operational efficiency.

Unit 3	Modern Surveying Technologies for Metro Projects	(09 hours)

Application of advanced surveying techniques in metro infrastructure projects, use of Total Station for precise measurements and setting out works, principles and applications of Differential Global Positioning System (DGPS) and Global Navigation Satellite System (GNSS), LiDAR technology for terrain and corridor mapping, drone-based surveying for data acquisition and monitoring, mobile mapping systems, and the role of modern surveying technologies in planning, design, construction, and maintenance of metro projects.

Unit 4	GIS and Remote Sensing Applications	(09 hours)

Fundamentals of Geographic Information Systems (GIS) and their applications in metro infrastructure planning, development of GIS databases for spatial data management, utility mapping and underground asset management, corridor mapping and route optimization, principles of remote sensing and interpretation of satellite imagery, and the use of GIS and remote sensing techniques for infrastructure planning, environmental assessment, and decision-making in metro projects.

Unit 5	Metro Stations and Depot Planning	(09 hours)

Classification and functional requirements of metro stations, principles of station layout planning and design, planning and design considerations for metro depots and maintenance facilities, passenger flow analysis for efficient circulation and crowd management, integration of stations with multimodal transport systems, accessibility features and universal design principles for inclusive infrastructure, and the role of station and depot planning in enhancing operational efficiency and passenger convenience.

LEARNING RESOURCES

Text books

1. Khanna, S. K., Justo, C. E. G., and Veeraragavan, A. (2017), Highway Engineering, Nem Chand & Bros., Roorkee.
2. Meyer, Michael D. and Miller, Eric J. (2013), Urban Transportation Planning: A Decision-Oriented Approach, 2nd Edition, McGraw-Hill Education, New York.
3. Hutchinson, B. G. (2010 Reprint), Principles of Urban Transport Systems Planning, Hemisphere Publishing Corporation, Washington D.C.

4. Vuchic, Vukan R. (2005), Urban Transit: Operations, Planning and Economics, John Wiley & Sons, Hoboken, New Jersey, USA.

Reference books

1. Rangwala, S. C. (2017), Railway Engineering, Charotar Publishing House Pvt. Ltd., Anand, Gujarat.
2. Saxena, S. C. and Arora, S. P. (2013), A Textbook of Railway Engineering, Dhanpat Rai Publications, New Delhi.

e-Books

GIS Fundamentals

Bolstad, Paul (2022), GIS Fundamentals: A First Text on Geographic Information Systems, XanEdu Publishing, Minnesota, USA.

https://www.gisfundamentals.org

Links to online SWAYAM/NPTELCourses

Remote Sensing and GIS
Instructor: IIT Roorkee Faculty.
https://nptel.ac.in/courses/105107155

Geoinformatics Applications
https://nptel.ac.in/courses/105107201

YouTube/Video Links

NPTEL Urban Transportation Planning Playlist
NPTEL Urban Transportation Planning Tom Mathew - YouTube

Delhi Metro Rail Corporation (DMRC)
Official DMRC - YouTube

LiDAR and Drone Surveying
https://www.youtube.com/results?search_query=LiDAR+Drone+Surveying+Infrastructure

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: **Course: Metro Planning, Alignment and Surveying Lab**

Teaching scheme	Credit	Examination	
Practical: 4 hours / week	02	OR TW	25 marks 25 marks

Course Objectives:

1. To develop knowledge and practical skills in modern surveying techniques and geospatial technologies used for metro rail planning, alignment, and infrastructure development.
2. To provide hands-on experience in data acquisition, mapping, alignment design, and field investigations through advanced surveying instruments, software applications, and site visits.

Course outcomes

On completion of the course, students will be able to:

1. Students will be able to perform modern surveying operations using Total Station, DGPS, Drone, GIS, and CAD tools for metro infrastructure projects.
2. Students will be able to analyze survey data, prepare utility and alignment maps, and evaluate field conditions for effective planning and execution of metro rail projects.

LIST OF PRACTICALS

Term work consists of a journal containing the following design, drawing and site visit report. Oral examination will be based on term work.

1. Total Station Survey

Conduct a Total Station survey to establish control points and determine the coordinates and elevations of selected points in a project area. Perform traversing, topographic detailing, data downloading, and preparation of contour and site plans suitable for metro alignment studies.

2. DGPS Survey

Carry out a Differential Global Positioning System (DGPS) survey to establish high-accuracy horizontal and vertical control points for metro infrastructure projects. Compare DGPS observations with conventional surveying methods and prepare coordinate and location reports.

3. Drone Survey Demonstration

Study the principles and applications of drone-based aerial surveying for metro corridor mapping. Conduct a demonstration of flight planning, image acquisition, photogrammetric processing, generation of orthomosaic images, Digital Elevation Models (DEM), and three-dimensional terrain models.

4. GIS Mapping Exercise

Prepare a Geographic Information System (GIS) map for a selected metro project area using spatial and attribute data. Develop thematic maps showing land use, transportation networks, environmental features, and other relevant information to support metro planning and decision-making.

5. Utility Mapping

Carry out a utility mapping exercise to identify and locate existing underground and above-ground utilities such as

water supply lines, sewer lines, electrical cables, gas pipelines, and communication networks. Prepare utility maps and analyze potential conflicts with proposed metro alignments.

6. Metro Alignment Design using CAD

Prepare a preliminary metro rail alignment using CAD software based on survey data and design constraints. Develop horizontal and vertical alignments considering geometric standards, existing infrastructure, land use, and engineering requirements for safe and economical metro operation.

7. Site Visit to Metro Corridor

Visit an ongoing or completed metro rail corridor to study field surveying practices, alignment selection, station locations, viaduct construction, utility shifting, and right-of-way management. Prepare a comprehensive site visit report highlighting survey techniques, construction challenges, and practical observations related to metro infrastructure development.

LEARNING RESOURCES

Text books

1. Khanna, S. K., Justo, C. E. G., and Veeraragavan, A. (2017), Highway Engineering, Nem Chand & Bros., Roorkee.
2. Meyer, Michael D. and Miller, Eric J. (2013), Urban Transportation Planning: A Decision-Oriented Approach, 2nd Edition, McGraw-Hill Education, New York.
3. Hutchinson, B. G. (2010 Reprint), Principles of Urban Transport Systems Planning, Hemisphere Publishing Corporation, Washington D.C.
4. Vuchic, Vukan R. (2005), Urban Transit: Operations, Planning and Economics, John Wiley & Sons, Hoboken, New Jersey, USA.

Reference books

1. Rangwala, S. C. (2017), Railway Engineering, Charotar Publishing House Pvt. Ltd., Anand, Gujarat.
2. Saxena, S. C. and Arora, S. P. (2013), A Textbook of Railway Engineering, Dhanpat Rai Publications, New Delhi.

Savitribai Phule Pune University
(Civil Engineering) 2024 Pattern
Semester VI

Course code: **Course: Planning, Estimation and Project Management for Metro Construction**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE	30 marks
		ESE	70 marks

Perquisites, if any: Project Management

Course Objectives:

1. Understand the planning and management processes involved in metro rail projects, including project life cycle, feasibility studies, DPR preparation, stakeholder management, and risk assessment.
2. Develop the ability to estimate quantities and costs for major metro infrastructure components and prepare project cost estimates using standard engineering practices.
3. Apply construction planning and scheduling techniques for effective execution of metro projects through resource optimization and project monitoring.
4. Understand various contracting and procurement methods used in metro infrastructure projects, including EPC, Design-Build, PPP models, and FIDIC contract principles.
5. Analyze the financial and economic viability of metro projects using modern appraisal techniques and case studies of metro rail systems.

Course outcomes

On completion of the course, learner will be able to:

1. Explain the planning framework of metro rail projects, including project life cycle, feasibility studies, DPR preparation, stakeholder management, and risk assessment for successful project implementation.
2. Estimate quantities and costs for major metro infrastructure components such as viaducts, pile foundations, stations, and tunnels, and prepare project cost estimates using standard engineering methods.
3. Apply construction planning and scheduling tools such as Work Breakdown Structure (WBS), CPM, and PERT for resource planning, construction sequencing, and project monitoring.
4. Analyze contract management and procurement strategies for metro projects, including tendering procedures, EPC, Design-Build, PPP models, and FIDIC contract concepts.
5. Evaluate the financial and economic performance of metro infrastructure projects using cost-benefit analysis, EIRR, life cycle costing, and financial viability assessment through practical case studies.

COURSE CONTENTS

Unit 1	Metro Project Planning	(09 hours)

Introduction to the planning and management of metro rail projects, project life cycle and its various phases from concept to operation, feasibility studies including technical, economic, financial, and environmental aspects, preparation of Detailed Project Reports (DPRs), stakeholder identification and management, public consultation

and regulatory requirements, risk identification and assessment, and strategies for effective planning and successful implementation of metro infrastructure projects.

Unit 2	Quantity Estimation and Costing	(09 hours)

Principles of quantity estimation and costing for metro construction projects, estimation of quantities for viaduct structures, pile foundations, station buildings, and underground tunnel works, preparation of schedules of quantities, methods of rate analysis for various construction activities, cost estimation techniques, preparation of project cost estimates, and application of standard specifications and cost indices in metro infrastructure projects.

Unit 3	Construction Planning and Scheduling	(09 hours)

Fundamentals of construction planning and project scheduling for metro projects, development of Work Breakdown Structure (WBS), application of Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT) for project scheduling, resource planning and allocation, equipment selection and planning, construction sequencing for elevated, underground, and station works, monitoring project progress, and optimization of time and resources for efficient project execution.

Unit 4	Contracts and Procurement	(09 hours)

Introduction to contract management and procurement practices in metro rail projects, tendering process and bid evaluation procedures, Engineering, Procurement, and Construction (EPC) contracts, Design-Build contracting approaches, Public-Private Partnership (PPP) models for infrastructure development, basic concepts and principles of FIDIC contract conditions, risk allocation among stakeholders, and contract administration for effective project delivery.

Unit 5	Financial and Economic Evaluation	(09 hours)

Fundamentals of financial and economic appraisal of metro infrastructure projects, cost-benefit analysis and evaluation of socio-economic impacts, Economic Internal Rate of Return (EIRR) and its significance, assessment of financial viability and project sustainability, life cycle cost analysis for metro assets and infrastructure, funding mechanisms for metro projects, and study of selected metro rail project case studies to understand planning, financing, implementation, and operational challenges.

LEARNING RESOURCES

Text books

1. Rangwala, S. C. (2022), Estimating, Costing and Valuation, Charotar Publishing House Pvt. Ltd., Anand, Gujarat.
2. Dutta, B. N. (2021), Estimating and Costing in Civil Engineering, UBS Publishers & Distributors Pvt. Ltd., New Delhi.
3. Nicholas, John M. and Steyn, Herman (2020), Project Management for Engineering, Business and Technology, 6th Edition, Routledge, New York.

4. Peurifoy, Robert L., Schexnayder, Clifford J., Shapira, Avi, and Schmitt, Robert (2018), Construction Planning, Equipment and Methods, 9th Edition, McGraw-Hill Education, New York.
5. Chitkara, K. K. (2014), Construction Project Management: Planning, Scheduling and Controlling, Tata McGraw-Hill Education Pvt. Ltd., New Delhi.

Reference books

1. Kerzner, Harold (2022), Project Management: A Systems Approach to Planning, Scheduling and Controlling, 13th Edition, John Wiley & Sons, Hoboken, USA.
2. Murdoch, John and Hughes, Will (2020), Construction Contracts: Law and Management, 6th Edition, Routledge, London.
3. Boardman, Anthony E., Greenberg, David H., Vining, Aidan R., and Weimer, David L. (2018), Cost-Benefit Analysis: Concepts and Practice, 5th Edition, Cambridge University Press, Cambridge.
4. Sullivan, William G., Wicks, Elin M., and Koelling, C. Patrick (2019), Engineering Economy, 17th Edition, Pearson Education, New York.
5. Yescombe, E. R. (2018), Public-Private Partnerships in Sub-Saharan Africa: Case Studies for Policymakers, Elsevier, Oxford.
6. Saleh Mubarak (2015), Construction Project Scheduling and Control, 3rd Edition, Wiley Publishing, USA.
7. Indian Railways and Metro Railway Authorities (Latest Edition), Manual for Standards and Specifications for Metro Railways, Government of India.

e-Books

Project Management Body of Knowledge

Project Management Institute (PMI) (2021), A Guide to the Project Management Body of Knowledge (PMBOK Guide), 7th Edition, PMI Publications, Pennsylvania, USA.

https://www.pmi.org/

Links to online SWAYAM/NPTELCourses

Project Management : https://nptel.ac.in/courses/110107081

YouTube/Video Links

NPTEL Construction Planning and Scheduling
:https://www.youtube.com/results?search_query=NPTEL+Construction+Planning+Scheduling

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: **Course: Planning, Estimation and Project Management for Metro Construction Lab**

Teaching scheme	Credit	Examination	
Practical: 4 hours / week	02	OR TW	25 marks 25 marks

Course Objectives:

1. To develop knowledge of planning, estimation, scheduling, contract management, and financial evaluation techniques for the effective execution of metro rail infrastructure projects.
2. To provide practical exposure to metro project implementation through case studies, site visits, and structural assessment for understanding real-world engineering and management practices.

Course outcomes

On completion of the course, students will be able to:

1. Students will be able to apply project planning, quantity estimation, scheduling, procurement, and financial appraisal methods to metro rail projects.
2. Students will be able to analyze metro infrastructure through case studies, site investigations, and structural assessment, and recommend suitable engineering and management solutions

LIST OF PRACTICALS

Term work consists of a journal containing the following design, drawing and site visit report. Oral examination will be based on term work.

1. Case Study on Metro Project Planning: Study any existing metro rail project and prepare a report covering project planning, life cycle, feasibility studies, DPR preparation, stakeholder management, risk assessment, and implementation strategies.
2. Quantity Estimation and Costing: Prepare quantity estimates, schedules of quantities, rate analysis, and approximate cost estimates for selected metro infrastructure components such as viaducts, stations, pile foundations, or tunnels.
3. Construction Planning and Scheduling: Develop a Work Breakdown Structure (WBS) and prepare CPM/PERT networks for a metro construction project, including resource allocation, equipment planning, and project scheduling.
4. Site Visit Report: Visit a metro rail construction site, station, viaduct, casting yard, or depot and prepare a report on construction methods, equipment used, safety measures, quality control practices, and project management aspects.
5. Case Study on Contracts and Financial Evaluation: Analyze the procurement process, EPC or PPP contracts, FIDIC principles, funding mechanisms, cost-benefit analysis, and financial viability of a selected metro rail project.
6. Structural Assessment Report: Carry out a visual structural assessment of any one metro-related structure or building, identify defects and distress, document observations, and suggest appropriate maintenance and rehabilitation measures.

LEARNING RESOURCES

Text books

1. Rangwala, S. C. (2022), Estimating, Costing and Valuation, Charotar Publishing House Pvt. Ltd., Anand, Gujarat.
2. Dutta, B. N. (2021), Estimating and Costing in Civil Engineering, UBS Publishers & Distributors Pvt. Ltd., New Delhi.
3. Nicholas, John M. and Steyn, Herman (2020), Project Management for Engineering, Business and Technology, 6th Edition, Routledge, New York.
4. Peurifoy, Robert L., Schexnayder, Clifford J., Shapira, Avi, and Schmitt, Robert (2018), Construction Planning, Equipment and Methods, 9th Edition, McGraw-Hill Education, New York.
5. Chitkara, K. K. (2014), Construction Project Management: Planning, Scheduling and Controlling, Tata McGraw-Hill Education Pvt. Ltd., New Delhi.

Reference books

1. Kerzner, Harold (2022), Project Management: A Systems Approach to Planning, Scheduling and Controlling, 13th Edition, John Wiley & Sons, Hoboken, USA.
2. Murdoch, John and Hughes, Will (2020), Construction Contracts: Law and Management, 6th Edition, Routledge, London.
3. Boardman, Anthony E., Greenberg, David H., Vining, Aidan R., and Weimer, David L. (2018), Cost-Benefit Analysis: Concepts and Practice, 5th Edition, Cambridge University Press, Cambridge.
4. Sullivan, William G., Wicks, Elin M., and Koelling, C. Patrick (2019), Engineering Economy, 17th Edition, Pearson Education, New York.
5. Yescombe, E. R. (2018), Public-Private Partnerships in Sub-Saharan Africa: Case Studies for Policymakers, Elsevier, Oxford.
6. Saleh Mubarak (2015), Construction Project Scheduling and Control, 3rd Edition, Wiley Publishing, USA.
7. Indian Railways and Metro Railway Authorities (Latest Edition), Manual for Standards and Specifications for Metro Railways, Government of India.

Savitribai Phule Pune University With effect from 2026-27														
HONORS in Architectural and Town Planning														
Course Code	**Course Type**	**Course Name**	**Teaching Scheme (Hrs./week)**			**Examination Scheme and Marks**					**Credits**			
			Theory	**Tutorial**	**Practical**	**CCE***	**End-Sem**	**Term**	**Practical**	**Oral**	**Theory**	**Tutorial**	**Practical**	**Total**
Semester V														
	Programme Core Course 1	Urban Housing and Infrastructure Planning	3	-	-	30	70	-	-	-	3	0	-	3
	Programme Core Course Lab 1	Urban Housing and Infrastructure Planning Lab	-	-	4	-	-	25	-	25	-	-	2	2
Semester VI														
	Programme Core Course 2	Sustainable Architecture and Landscape Design	3	-	-	30	70	-	-	-	3	0	-	3
	Programme Core Course Lab 2	Sustainable Architecture and Landscape Design Lab	-	-	4	-	-	25	-	25	-	-	2	2
Total			**6**	**0**	**8**	**60**	**140**	**50**	**0**	**50**	**6**	**0**	**4**	**10**
			14 Hrs.			**300 Marks**					**10 Credits**			

Savitribai Phule Pune University
(Civil Engineering) 2024 Pattern

Semester V

Course code: HONORS **Course:** Urban Housing and Infrastructure Planning

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE	30 marks
		ESE	70 marks

Perquisites, if any: Basic Civil Engineering, BTAP

Course Objectives:

1. Understand the principles of housing planning, residential neighbourhood development, housing standards, and affordable housing schemes.
2. Familiarize students with housing policies, financing mechanisms, cooperative housing, public-private partnerships, and urban housing development strategies.
3. Develop knowledge of urban infrastructure planning processes, demand forecasting, planning standards, and sustainable infrastructure development.
4. Introduce the planning and management of essential urban services and utility systems, including smart infrastructure solutions.
5. Provide an understanding of the formulation, appraisal, financial evaluation, and environmental aspects of urban infrastructure projects through practical case studies.

Course outcomes

On completion of the course, learner will be able to:

1. Explain housing planning concepts, housing standards, residential layouts, and affordable housing initiatives for sustainable urban development.
2. Analyze housing policies, financing systems, cooperative housing models, PPP approaches, and slum redevelopment strategies in the Indian context.
3. Apply urban infrastructure planning principles, URDPFI guidelines, and demand forecasting techniques to plan sustainable urban infrastructure systems.
4. Evaluate the planning and management of urban utility services, including water supply, sewerage, drainage, solid waste management, power, telecommunication, and smart utility systems.
5. Assess urban infrastructure projects using project appraisal techniques, cost-benefit analysis, financial feasibility, environmental and social impact assessments, and case study evaluation.

COURSE CONTENTS

Unit 1	Housing Planning and Residential Development	(09 hours)

Housing concepts and their role in urban development, housing demand and need assessment based on demographic and socio-economic factors, housing standards and norms, principles of residential neighbourhood planning, criteria for site selection and preparation of housing layouts, concepts and strategies for affordable housing, and an overview of the Pradhan Mantri Awas Yojana (PMAY), including its objectives, components, and role in promoting inclusive

and sustainable housing development.

Unit 2	Housing Policies and Urban Development	(09 hours)

Evolution and framework of housing policies in India, role and functions of housing finance institutions, concepts and management of cooperative housing, public-private partnership models in housing development, planning and implementation of affordable housing projects, slum redevelopment and rehabilitation policies and strategies, and institutional, legal, and socio-economic aspects of urban housing development.

Unit 3	Urban Infrastructure Planning	(09 hours)

Urbanization trends and infrastructure requirements, principles and process of urban infrastructure planning, application of the URDPFI Guidelines and service level benchmarks, methods of infrastructure demand forecasting, integration of land use and infrastructure planning, and concepts of sustainable, resilient, and environmentally responsible urban infrastructure development.

Unit 4	Urban Services and Utility Systems	(09 hours)

Planning and management of urban water supply systems, sewerage and storm water drainage systems, solid waste management practices, power distribution and telecommunication infrastructure, integration of urban utility networks, smart utility management using modern technologies, and sustainable approaches for efficient and resilient urban service delivery.

Unit 5	Urban Infrastructure Projects	(09 hours)

Concepts of urban infrastructure project formulation and appraisal, techniques of cost-benefit analysis and financial feasibility assessment, environmental and social impact assessment procedures, project planning and risk considerations, stakeholder participation in infrastructure development, and case studies of urban infrastructure projects highlighting planning, financing, implementation, and sustainable management practices.

LEARNING RESOURCES

Text books

1. Punmia, B. C., Jain, A. K., and Jain, Arun K. (2023 Edition), Water Supply Engineering, Laxmi Publications Pvt. Ltd., New Delhi.
2. Roy, Uttam Kumar (2022), Housing Policy & Planning, NPTEL/SWAYAM Course Material, Department of Architecture and Planning, IIT Roorkee.
3. Garg, S. K. (2021 Edition), Environmental Engineering (Volume I & II), Khanna Publishers, New Delhi.
4. Kumar, Alok; Sen, J., and others (2013), Urban Infrastructure Planning, Management and Finance, Sage Publications India Pvt. Ltd., New Delhi.
5. Hall, Peter and Huxley, Michael (2019), Urban and Regional Planning, 5th Edition, Routledge, London.
6. Sivaramakrishnan, K. C. (2011), Housing and Urban Development in India, Oxford University Press, New Delhi.

Reference books

1. Mishan, E. J. and Quah, Euston (2020), Cost-Benefit Analysis, 6th Edition, Routledge, London.
2. Rajaraman, N. (2015), Infrastructure Development and Financing, PHI Learning Pvt. Ltd., New Delhi.
3. Gupta, K. R. (2010), Housing in India, Atlantic Publishers & Distributors Pvt. Ltd., New Delhi.
4. Joy, P. K. (2010), Project Planning and Control, Macmillan India Ltd., New Delhi.
5. Canter, Larry W. (1996), Environmental Impact Assessment, McGraw-Hill Education, New York.

Government Publications

1. **URDPFI Guidelines**
   Government of India, Ministry of Urban Development (2015), Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines, Government of India, New Delhi.
   E-Book PDF:
   https://dspace.kila.ac.in/items/35434a5b-aeb5-49ad-88d0-0bcd3183d2ce
2. **PMAY Guidelines**
   Government of India, Ministry of Housing and Urban Affairs (latest version), Pradhan Mantri Awas Yojana (Urban) Mission Guidelines, Government of India, New Delhi.
   Official Website:https://pmay-urban.gov.in
3. **Service Level Benchmarks Handbook**
   Ministry of Housing and Urban Affairs, Government of India, Service Level Benchmarks Handbook for Urban Services, Government of India, New Delhi.
   Official Portal:https://mohua.gov.in

e-Books & Digital Resources

1. National Institute of Urban Affairs (NIUA) :https://niua.in
2. Ministry of Housing and Urban Affairs :https://mohua.gov.in
3. Town and Country Planning Organisation :https://tcpo.gov.in

Links to online SWAYAM/NPTELCourses

1. Housing Policy & Planning
Instructor: Prof. Uttam Kumar Roy, IIT Roorkee. The course covers housing policy, affordable housing, housing finance, housing planning, informal housing, and housing management.
Course:https://nptel.ac.in/courses/124107001
2. Urban Governance and Development Management
Instructor: Prof. Uttam Kumar Roy, IIT Roorkee. This course discusses Smart Cities, PMAY, AMRUT, urban governance, and infrastructure management.
Course:https://onlinecourses.nptel.ac.in/noc24_ar17/preview

YouTube/Video Links

NPTEL Housing Policy & Planning Playlist
Video lectures by Prof. Uttam Kumar Roy.
https://nptel.ac.in/courses/124107001

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: **Course: Urban Housing and Infrastructure Planning Lab**

Teaching scheme	Credit	Examination	
Practical: 4 hours / week	02	OR TW	25 marks 25 marks

Course Objectives:

1. To develop practical skills in housing layout planning, urban infrastructure mapping, and the assessment of urban services using modern planning tools and standards.
2. To enable students to analyze affordable housing and urban infrastructure projects and apply planning principles for sustainable neighborhood development.

Course outcomes

On completion of the course, students will be able to:

1. Apply planning techniques and software tools to prepare housing layouts, infrastructure maps, and service level assessments for urban areas.
2. Evaluate housing and urban infrastructure projects and develop sustainable planning solutions through feasibility studies and neighborhood planning projects.

LIST OF PRACTICALS

Term work consists of a journal containing the following design, drawing and site visit report. Oral examination will be based on term work.

1. **Housing Layout Planning using AutoCAD:**
   Prepare a residential housing layout using AutoCAD by incorporating planning standards, road networks, open spaces, and basic urban services.
2. **Study of Affordable Housing Projects:**
   Conduct a case study of an affordable housing project, including planning aspects, infrastructure provisions, and government housing schemes such as PMAY.
3. **Urban Infrastructure Mapping:**
   Prepare maps of urban infrastructure facilities such as roads, water supply, sewerage, drainage, and public utilities for a selected area.
4. **Service Level Benchmarking:**
   Assess the performance of urban services using standard service level indicators and identify gaps for infrastructure improvement.
5. **Infrastructure Project Feasibility Study:**
   Carry out a preliminary feasibility study of an urban infrastructure project considering technical, financial, environmental, and social aspects.
6. **Mini Project on Neighborhood Planning:**
   Develop a neighborhood planning proposal by integrating land use, housing, transportation, urban services, and sustainable planning principles.

LEARNING RESOURCES

Text books

1. Punmia, B. C., Jain, A. K., and Jain, Arun K. (2023 Edition), Water Supply Engineering, Laxmi Publications Pvt. Ltd., New Delhi.
2. Roy, Uttam Kumar (2022), Housing Policy & Planning, NPTEL/SWAYAM Course Material, Department of Architecture and Planning, IIT Roorkee.
3. Garg, S. K. (2021 Edition), Environmental Engineering (Volume I & II), Khanna Publishers, New Delhi.
4. Kumar, Alok; Sen, J., and others (2013), Urban Infrastructure Planning, Management and Finance, Sage Publications India Pvt. Ltd., New Delhi.
5. Hall, Peter and Huxley, Michael (2019), Urban and Regional Planning, 5th Edition, Routledge, London.
6. Sivaramakrishnan, K. C. (2011), Housing and Urban Development in India, Oxford University Press, New Delhi.

Reference books

1. Mishan, E. J. and Quah, Euston (2020), Cost-Benefit Analysis, 6th Edition, Routledge, London.
2. Rajaraman, N. (2015), Infrastructure Development and Financing, PHI Learning Pvt. Ltd., New Delhi.
3. Gupta, K. R. (2010), Housing in India, Atlantic Publishers & Distributors Pvt. Ltd., New Delhi.
4. Joy, P. K. (2010), Project Planning and Control, Macmillan India Ltd., New Delhi.
5. Canter, Larry W. (1996), Environmental Impact Assessment, McGraw-Hill Education, New York.

Government Publications

1. **URDPFI Guidelines**
   Government of India, Ministry of Urban Development (2015), Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines, Government of India, New Delhi.
   E-Book PDF:
   https://dspace.kila.ac.in/items/35434a5b-aeb5-49ad-88d0-0bcd3183d2ce

2. **PMAY Guidelines**
   Government of India, Ministry of Housing and Urban Affairs (latest version), Pradhan Mantri Awas Yojana (Urban) Mission Guidelines, Government of India, New Delhi.
   Official Website:https://pmay-urban.gov.in

3. **Service Level Benchmarks Handbook**
   Ministry of Housing and Urban Affairs, Government of India, Service Level Benchmarks Handbook for Urban Services, Government of India, New Delhi.
   Official Portal:https://mohua.gov.in

Savitribai Phule Pune University
(Civil Engineering) 2024 Pattern

Semester VI

Course code: HONORS. **Course: Sustainable Architecture and Landscape Design**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Perquisites, if any: **Basic Civil Engineering**

Course Objectives:

1. Understand the evolution of architecture and human settlements and their influence on contemporary urban planning and development.
2. Familiarize students with the principles of sustainable development, green building concepts, and sustainable building rating systems for environmentally responsible construction.
3. Develop knowledge of climate-responsive architectural design and sustainable urban planning strategies for energy-efficient and resilient built environments.
4. Introduce the principles of landscape planning and design for enhancing ecological, aesthetic, and functional aspects of urban spaces.
5. Provide an understanding of environmental planning and urban ecology concepts to promote biodiversity conservation and climate-resilient urban development.

Course outcomes

On completion of the course, learner will be able to:

1. Explain the historical evolution of architecture and human settlements and relate traditional and contemporary planning concepts to sustainable urban development.
2. Apply the principles of sustainable development and evaluate green building practices, rating systems, and net-zero energy building concepts.
3. Analyze climate-responsive architectural strategies, including passive design techniques and sustainable urban form, for improving building and urban environmental performance.
4. Design and evaluate landscape elements and green infrastructure by applying the principles of landscape architecture and sustainable site planning.
5. Assess environmental planning strategies, urban ecological systems, blue-green infrastructure, and climate-resilient planning approaches for sustainable cities.

COURSE CONTENTS

Unit 1	Evolution of Architecture and Human Settlements	(09 hours)

Evolution of architecture and human settlements, salient features of ancient Indian architecture, planning principles of the Indus Valley Civilization and its urban settlements, characteristics of Mughal and Colonial architecture, trends in modern urban development, and contemporary planning concepts emphasizing sustainable, inclusive, and resilient built environments.

Unit 2	Sustainable Development and Green Buildings	(09 hours)

Principles and dimensions of sustainable development, overview of the United Nations Sustainable Development Goals (SDGs) and their relevance to the built environment, concepts of green buildings and sustainable construction practices, green building assessment and rating systems including GRIHA and Indian Green Building Council, energy-efficient building strategies, and principles and applications of net-zero energy buildings.

Unit 3	Climate Responsive Architecture and Urban Sustainability	(09 hours)

Concepts of climate-responsive architecture, building orientation for energy efficiency, passive solar design techniques, natural ventilation and daylighting strategies, thermal comfort principles and assessment, sustainable urban form, compact and mixed-use development, and eco-city concepts for enhancing environmental performance and urban sustainability.

Unit 4	Landscape Planning and Design	(09 hours)

Fundamentals and principles of landscape architecture, site analysis and landscape suitability assessment, planning and design of urban parks and green spaces, concepts and applications of green roofs and vertical gardens, selection of landscape elements and vegetation, and principles of landscape sustainability for improving urban environmental quality and resilience.

Unit 5	Environmental Planning and Urban Ecology	(09 hours)

Concepts of urban ecology and biodiversity conservation, watershed-based planning and integrated water resource management, causes and mitigation measures for urban heat island effects, planning and design of blue-green infrastructure systems, climate-resilient urban planning strategies, and the role of ecological approaches in creating sustainable and adaptive urban environments.

LEARNING RESOURCES

Text books

1. "Sustainable Architecture: Low-Tech Houses" by David Thorpe, 2020, Published by: Routledge.
2. "Sustainable Construction: Green Building Design and Delivery" by Charles J. Kibert, 2016 (Latest Edition), Published by: Wiley.
3. "The Ecology of Building Materials" by Bjorn Berge, 2017 (Latest Edition), Published by: Routledge.
4. "Introduction to Sustainable Design" by David Bergman, 2020, Published by: Routledge.

Reference books

1. "Designing Green Buildings: Guide to Sustainable Architecture" by David J. Neuman, 2021, Published by: Bloomsbury.
2. "Sustainable Urbanism: Urban Design With Nature" by Douglas Kelbaugh, 2021, Published by: Wiley.
3. "Green Building and Sustainable Design" by Joseph S. Valenzuela, 2022, Published by: Springer.
4. "Ecological Architecture: A Critical History" by Thomas R. Baird, 2021, Published by: Routledge.

e-Books

1. "Sustainable Design: A Critical Guide" by David Bergman, 2020, Published by: Princeton Architectural Press
2. "Building Green: A Complete How-to Guide to Alternative Building Methods" by Clarke Snell and Tim Callahan, 2021, Published by: New Society Publishers

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern
Semester VI

Course code: **Course: Sustainable Architecture and Landscape Design Lab**

Teaching scheme	Credit	Examination	
Practical: 4 hours / week	02	OR TW	25 marks 25 marks

Course Objectives:

1. To develop practical skills in sustainable architectural design, green building assessment, and landscape planning using environmental and planning principles.
2. To enable students to apply climate-responsive and ecological planning concepts for designing sustainable and resilient built environments.

Course outcomes

On completion of the course, students will be able to:

1. Apply sustainable architecture, green building, and landscape planning principles to analyze and design environmentally responsible built spaces.
2. Develop sustainable planning solutions by integrating climate-responsive design, urban ecology, and environmental assessment techniques into practical projects.

LIST OF PRACTICALS

Term work consists of a journal containing the following design, drawing and site visit report. Oral examination will be based on term work.

1. Architectural Heritage Study and Documentation
Conduct a case study of a historical or heritage structure to analyze its architectural features, planning principles, and sustainable design elements. Prepare a report with sketches, photographs, and observations.

2. Green Building Rating Assessment
Evaluate an existing building based on green building principles and assessment criteria of GRIHA or Indian Green Building Council. Identify sustainable features and recommend measures for improving its environmental performance.

3. Climate Responsive Building Design
Analyze the orientation and climatic conditions of a selected building or site and propose passive solar design, natural ventilation, and daylighting strategies to improve energy efficiency and thermal comfort.

4. Landscape Planning and Site Design
Prepare a landscape plan for a residential, institutional, or public space by incorporating green spaces, pathways, water features, native vegetation, and sustainable landscape elements such as green roofs or vertical gardens.

5. Urban Ecology and Environmental Assessment
Conduct an environmental assessment of a selected urban area by studying biodiversity, urban green cover, heat island effects, and ecological features, and suggest measures for ecological improvement.

6. Mini Project on Sustainable Campus or Neighborhood Planning
Develop a sustainable master plan for a campus or neighborhood integrating climate-responsive buildings, landscape design, blue-green infrastructure, renewable energy features, and ecological planning principles.

LEARNING RESOURCES

Text books

1. "Sustainable Architecture: Low-Tech Houses" by David Thorpe, 2020, Published by: Routledge.
2. "Sustainable Construction: Green Building Design and Delivery" by Charles J. Kibert, 2016 (Latest Edition), Published by: Wiley.
3. "The Ecology of Building Materials" by Bjorn Berge, 2017 (Latest Edition), Published by: Routledge.
4. "Introduction to Sustainable Design" by David Bergman, 2020, Published by: Routledge.

Reference books

1. "Designing Green Buildings: Guide to Sustainable Architecture" by David J. Neuman, 2021, Published by: Bloomsbury.
2. "Sustainable Urbanism: Urban Design With Nature" by Douglas Kelbaugh, 2021, Published by: Wiley.
3. "Green Building and Sustainable Design" by Joseph S. Valenzuela, 2022, Published by: Springer.
4. "Ecological Architecture: A Critical History" by Thomas R. Baird, 2021, Published by: Routledge.

e-Books

1. "Sustainable Design: A Critical Guide" by David Bergman, 2020, Published by: Princeton Architectural Press
2. "Building Green: A Complete How-to Guide to Alternative Building Methods" by Clarke Snell and Tim Callahan, 2021, Published by: New Society Publishers

Savitribai Phule Pune University

With effect from 2026-27

HONORS in Structural Engineering

Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks					Credits			
			Theory	Tutorial	Practical	CCE*	End-Sem	Term work	Practical	Oral	Theory	Tutorial	Practical	Total
Semester V														
	Programme Core Course 1	Fundamentals of Structural Engineering	3	-	-	30	70	-	-	-	3	0	-	3
	Programme Core Course Lab 1	Fundamentals of Structural Engineering Lab	-	-	4	-	-	25	-	25	-	-	2	2
Semester VI														
	Programme Core Course 2	Modern Construction Techniques and Rehabilitation	3	-	-	30	70	-	-	-	3	0	-	3
	Programme Core Course Lab 2	Modern Construction Techniques and Rehabilitation Lab	-	-	4	-	-	25	-	25	-	-	2	2
Total			**6**	**0**	**8**	**60**	**140**	**50**	**0**	**50**	**6**	**0**	**4**	**10**
			14 Hrs.			**300 Marks**					**10 Credits**			

Savitribai Phule Pune University
(Civil Engineering) 2024 Pattern

Semester V

Course code: HONORS **Course: Fundamentals of Structural Engineering**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Perquisites, if any: Engineering Mechanics, Mechanics of structure

Course Objectives:

1. To introduce the fundamentals of structural systems and load transfer mechanisms in RCC, steel, and composite structures.
2. To develop an understanding of various loads and forces acting on buildings and their structural significance.
3. To familiarize students with basic structural analysis and modelling using industry-standard software tools
4. To impart knowledge of structural drawings, reinforcement detailing, and bar bending schedules.
5. To expose students to practical applications of structural engineering through the study of different building and industrial structures.

Course outcomes

On completion of the course, learner will be able to:

1. Understand the behavior and selection of various structural systems used in buildings.
2. Identify and evaluate different types of loads acting on structures and their effects.
3. Develop basic structural models and perform elementary structural analysis using industry-standard software.
4. Interpret structural drawings and prepare elementary reinforcement detailing and bar bending schedules.
5. Apply structural engineering concepts to analyze and appreciate practical building and industrial structures through case studies.

COURSE CONTENTS

Unit I	Structural Systems	(09 hours)
Load transfer mechanism in structures, Types of structural systems, RCC framed structures, Steel framed structures and Composite structures		
Unit 2	**Building Loads**	**(09 hours)**
Dead loads, Live loads, Wind loads, Earthquake loads (basic concepts) and other loads & forces		
Unit 3	**Introduction to Software**	**(09 hours)**
Overview of STAAD Pro, SAP and ETABS, Structural modelling, Load application and Interpretation of results		
Unit 4	**Structural Drawings and Detailing**	**(09 hours)**
Reading of structural drawings, Reinforcement detailing, bar bending schedules and Introduction to detailing software		

Unit 5	Case Studies	(09 hours)

Residential buildings, Commercial buildings, Public building and Industrial building & structures

LEARNING RESOURCES

Text books

1. Limit State Design of Steel Structures, S K Duggal, Tata McGraw Hill Education, New Delhi
2. Design of Steel Structure by Limit State Method as per IS: 800- 2007, Bhavikatti S S, I. K. International publishing house, New Delhi
3. Illustrated Reinforced Concrete Design, Dr. V. L. Shah and Dr. S. R. Karve, Structures Publications, Pune.
4. Structural Analysis-I&II byS.S.Bhavikatti,VikasPublishingHousePvt.Ltd.

Reference books

1. Design of Steel Structure, N Subramanian, Oxford University Press, New Delhi
2. Limit State Design in Structural Steel, M. R. Shiyekar, PHI, Delhi
3. Illustrated Design of Reinforced Concrete Buildings (G+3), Dr. V. L. Shah and Dr. S. R. Karve, Structures Publications, Pune.
4. RCC Analysis and Design, Sinha and Roy, S. Chand and Co. New Delhi.
5. Intermediate Structural Analysis by R. C. Hibbler, Pearson Education Publishers.

Links to online SWAYAM/NPTELCourses

https://nptel.ac.in/courses/105105162
https://nptel.ac.in/courses/105105105
https://www.csiamerica.com/support/watch-and-learn
https://www.bentley.com/education/help/

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: **Course: Fundamentals of Structural Engineering Lab**

Teaching scheme	Credit	Examination	
Practical: 4 hours / week	02	OR TW	25 marks 25 marks

Course Objectives:

1. To develop the ability to model and analyze basic building structural systems using suitable structural engineering software.
2. To impart practical skills for preparing structural drawings and interpreting analysis results for engineering applications.

Course outcomes

On completion of the course, students will be able to:

1. Model and analyse building frame structures using suitable structural engineering software for various loading conditions.
2. Prepare and interpret structural drawings and analysis reports for practical building engineering applications.

LIST OF PRACTICALS

Term work consists of a journal containing the following design, drawing and site visit report. Oral examination will be based on term work.

1. Introduction to Structural Modelling Software:
Introduction to the structural modelling software interface, unit systems, grid layout, material and section properties, and development of a simple two-dimensional (2D) frame model.

2. Modelling and Analysis of a Single-Storey Building Frame:
Modelling of a single-storey building frame including beams and columns, assignment of supports and loads, and structural analysis for the evaluation of frame behaviour.

3. Modelling of a Multi-Storey Building Frame:
Development of a multi-storey building frame with generation of storey levels and floor plans, assignment of dead and live loads, and structural analysis to study displacements and internal forces.

4. Load Combination and Structural Analysis:
Application of load combinations as per relevant Indian Standards and structural analysis for the evaluation of bending moments, shear forces, axial forces, and support reactions.

5. Preparation of Structural Drawings:
Preparation of beam, column, slab, and footing layout drawings, framing plans, and structural detailing using suitable structural modelling and drafting software.

6. Mini Project on Building Frame Modelling and Documentation:
Complete modelling and analysis of a small RCC or steel building frame, including structural drawings and a report covering modelling assumptions, load calculations, analysis results, and conclusions.

LEARNING RESOURCES

Text books

1. Limit State Design of Steel Structures, S K Duggal, Tata McGraw Hill Education, New Delhi
2. Design of Steel Structure by Limit State Method as per IS: 800- 2007, Bhavikatti S S, I. K. International publishing house, New Delhi
3. Illustrated Reinforced Concrete Design, Dr. V. L. Shah and Dr. S. R. Karve, Structures Publications, Pune.
4. Structural Analysis-I&II byS.S.Bhavikatti,VikasPublishingHousePvt.Ltd.

Reference books

1. Design of Steel Structure, N Subramanian, Oxford University Press, New Delhi
2. Limit State Design in Structural Steel, M. R. Shiyekar, PHI, Delhi
3. Illustrated Design of Reinforced Concrete Buildings (G+3), Dr. V. L. Shah and Dr. S. R. Karve, Structures Publications, Pune.
4. RCC Analysis and Design, Sinha and Roy, S. Chand and Co. New Delhi.
5. Intermediate Structural Analysis by R. C. Hibbler, Pearson Education Publishers.

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(Civil Engineering) 2024 Pattern

Semester VI

Course code: HONORS. **Course: Modern Construction Techniques and Rehabilitation**

Teaching scheme	Credit	Examination	
Theory: 3 hours / week	03	CCE ESE	30 marks 70 marks

Perquisites, if any: Concrete Technology

Course Objectives:

1. To introduce advanced and sustainable construction materials and their engineering applications.
2. To familiarize students with emerging construction technologies and modern structural systems.
3. To develop knowledge of structural inspection methods and condition assessment of existing structures
4. To introduce smart technologies and digital tools used for monitoring and managing infrastructure systems.
5. To impart knowledge of structural deterioration mechanisms and rehabilitation techniques for existing structures.

Course outcomes

On completion of the course, learner will be able to:

1. Explain the properties, applications, and advantages of advanced and sustainable construction materials used in modern infrastructure.
2. Describe and compare contemporary construction technologies, including prefabrication, modular construction, prestressed, composite, and pre-engineered structural systems.
3. Perform basic structural inspection and condition assessment by identifying defects, diagnosing deterioration, and preparing inspection reports for existing structures.
4. Explain the principles and applications of structural health monitoring, sensor technologies, and digital tools used in smart infrastructure systems.
5. Recommend appropriate rehabilitation and strengthening techniques, including the use of advanced materials such as FRP, for the repair and retrofitting of deteriorated structures.

COURSE CONTENTS

Unit 1	Modern Construction Materials	(09 hours)

High strength and high performance concrete, Self-compacting concrete, Self curing concrete, Light weight concrete, Fibre reinforced concrete and Sustainable construction materials

Unit 2	Construction Technology Trends	(09 hours)

Prefabrication, Modular construction, Precast structures, Prestressed structures, Composite structures and Pre-engineered buildings

Unit 3	Structural Inspection and Condition Assessment	(09 hours)

Purpose and importance of structural inspection, Visual inspection techniques, Identification of defects in RCC and Steel structures, Cracks in buildings: types, causes & remedies, Condition assessment of existing structures and Preparation of inspection reports

Unit 4	Smart Infrastructure	(09 hours)

Structural health monitoring, Sensors in structures and Digital technologies in construction

Unit 5	Structural Rehabilitation	(09 hours)

Causes of deterioration, strengthening materials, strengthening techniques, Strengthening methods and Strengthening of RC structure using FRP

LEARNING RESOURCES

Text books

1. Concrete Technology: Theory and Practice, M. S. Shetty, S. Chand Publication
2. Concrete Repair and Maintenance, P. H. Emmons and G M Sabnis, Galgotia Publication.
3. Repairs and Rehabilitation, Compilation from Indian Concrete Journals

Reference books

1. ACI 440.2R-08, Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures, American Concrete Institute.
2. Handbook on Repair and Rehabilitation of RCC Buildings, S. K. Bhattacharya

Links to online SWAYAM/NPTELCourses

https://nptel.ac.in/courses/105102195
https://nptel.ac.in/courses/105106202
https://nptel.ac.in/courses/114106046

Savitribai Phule Pune University
TE (Civil Engineering) 2024 Pattern

Course code: **Course: Modern Construction Techniques and Rehabilitation Lab**

Teaching scheme	Credit	Examination	
Practical: 4 hours / week	02	OR TW	25 marks 25 marks

Course Objectives:

1. To familiarize students with modern construction materials, advanced construction technologies, and smart infrastructure systems used in contemporary structural engineering.
2. To develop practical skills in structural inspection, condition assessment, and rehabilitation planning through field studies, case studies, and technical report preparation.

Course outcomes

On completion of the course, students will be able to:

1. Evaluate modern construction materials, advanced construction technologies, and smart infrastructure systems for sustainable structural engineering applications.
2. Perform structural inspection and condition assessment of existing structures and recommend appropriate rehabilitation and strengthening measures based on engineering principles.

LIST OF PRACTICALS

Term work consists of a journal containing the following design, drawing and site visit report. Oral examination will be based on term work.

1: Study of Modern Construction Materials
Study the properties, applications, and performance characteristics of high-strength concrete, self-compacting concrete, self-curing concrete, lightweight concrete, fibre-reinforced concrete, and sustainable construction materials through laboratory demonstrations and case studies.

2: Case Study on Modern Construction Technology
Prepare a case study report on any one modern construction technology such as prefabrication, modular construction, precast construction, prestressed structures, composite structures, or pre-engineered buildings, highlighting construction methodology, advantages, limitations, and practical applications.

3: Site Visit and Report on Modern Construction Practices
Conduct a site visit to a construction project employing advanced construction technologies or sustainable construction practices and prepare a detailed site visit report covering materials, construction methods, quality control measures, and safety practices.

4: Structural Inspection of an Existing Building
Carry out a visual inspection of an existing RCC or steel building to identify defects such as cracks, corrosion, spalling, leakage, and deformation, and document observations using standard inspection procedures.

5: Structural Assessment Report of Any One Type of Building
Prepare a structural condition assessment report for an existing residential, commercial, industrial, or institutional building, including identification of structural deficiencies, probable causes of deterioration, assessment of serviceability, and recommendations for maintenance or rehabilitation.

6: Case Study on Structural Rehabilitation and Smart Infrastructure
Prepare a technical report on the rehabilitation of an existing structure or the implementation of smart infrastructure technologies such as structural health monitoring systems, sensors, digital monitoring techniques, and FRP strengthening methods, including recent engineering applications.

LEARNING RESOURCES

Text books

1. Concrete Technology: Theory and Practice, M. S. Shetty, S. Chand Publication
2. Concrete Repair and Maintenance, P. H. Emmons and G M Sabnis, Galgotia Publication.
3. Repairs and Rehabilitation, Compilation from Indian Concrete Journals

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