Shivaji University

Vidya Nagar, Kolhapur, Maharashtra 416004

School of Engineering and Technology (Department of Technology)

As per NEP 2020 guidelines

Final Year B.Tech. (Civil Engineering), Detailed Curriculum 2026-27 onwards

A. Engineering Graduate Attributes

1. Domain specific Engineering Knowledge
2. Problem Analysis Ability
3. Acquiring Skills that enable them to Design & Develop Solutions to the Problems
4. Capacity to investigate Complex Problems
5. Familiarity of using Modern Tools
6. Understanding Engineer's role and connectivity towards Society
7. Awareness about Environment & Sustainability
8. Practicing ethics and values
9. Ability to work as an Individual & in a Team also
10. Acquiring Communication skills
11. Becoming well verse with task of Project management & Finance aspects
12. Developing Lifelong Learning attitude

B. Tech. (Civil Engineering) Program: Vision, Mission, PEOs and POs.

Vision

To be a centre of excellence of quality education in Civil Engineering and Technology with global perspectives.

Mission

1. To enhance the quality of civil engineering education in the undergraduate program through excellent educational programs, creativity, research and enriched with soft skills.
2. To develop the eagerness of graduates for higher education, professional career and competitive examinations.
3. To promote excellence in teaching, research and development.
4. To produce competent technical manpower in the field of Civil Engineering to cater for the needs of industry and society, academic institutions and R and D institutions.

Program Educational Objectives (PEOs):

PEO1: Graduates of the program shall establish themselves in successful careers in civil engineering, construction engineering, or a related field.

PEO2: Graduates of the program shall collaborate effectively on multi-disciplinary teams to address the needs of society and the environment.

PEO3: Graduates of the program shall pursue lifelong learning, professional development, and registration as appropriate for their employers.

Program Outcomes (POs)

PO1: Apply basic knowledge of science, mathematics and engineering to solve complex Civil Engineering problems.

PO2: Analyze complex Civil Engineering problems to arrive at appropriate solutions using the fundamentals of science and engineering.

PO3: Design and develop safe and environmentally friendly systems and their components to meet specific needs.

PO4: Design and conduct experiments for complex Civil Engineering problems to come out with valid conclusions.

PO5: Select and apply appropriate techniques and state of the art tools for accomplishing complex Civil Engineering activities.

PO6: Assess societal, cultural and legal issues and consequent responsibilities pertaining to Civil Engineering practice.

PO7: Understand the impact of Civil Engineering projects on the environment and the need for sustainable development.

PO8: Practice professional ethics while discharging responsibilities.

PO9: Work in a team as a member or as a leader in diverse professional environments.

PO10: Comprehend and communicate effectively complex Civil Engineering activities through presentations and reports.

PO11: Understand financial aspects and apply management principles to Civil Engineering projects.

PO12: Engage in independent and lifelong learning in the context of rapid technological changes.

Program Specific Outcomes (PSOs)

PSO1: Able to perform economic analysis, quality checks, time/labour management and cost estimates related to design, construction, operations and maintenance of systems in the civil technical specialities

PSO2: Able to plan and prepare design and construction documents, such as specifications, contracts, change orders, engineering drawings, and construction schedules

C. Component wise distribution of credits

Semester		I	II	III	IV	V	VI	VII	VIII	Total Credits (Provided)	Requirement as per Maharashtra Government Resolution	AICTE
Basic Science Course	BSC	8	8	3	--	--	--	--	--	**19**	14-18	24
Engineering Science Courses	ESC	12	12	--	--	--	--	--	--	**24**	16-12	20
Program Core Courses	PCC	--	--	14	15	15	7	4	--	**64**	44-56	58
Program Elective Course	PEC	--	--	--	--	3	6	6	--	**12**	20	26
Multidisciplinary Minor	MDM	--	--	--	3	3	3	3	2	**14**	14	18
Open Elective	OE	--	--	--	--	--	3	3	6	**6**	8	12
Vocational and Skill Enhancement Course	VSEC	--	--	--	1	1	3	--	--	**5**	8	
Ability Enhancement Course (AEC)	Humanities and Social Sciences, Management Courses (HSSM)	--	--	1	1	1	--	--	--	**3**	4	
Entrepreneurship/ Economics/ Management Courses		--	--	--	--	--	--	3	--	**3**	4	6
Indian Knowledge System		1	1	--	--	--	--	--	2	**4**	2	2
Value Education Course		--	--	2	2	--	--	1	1	**6**	4	
Research Methodology	Experiential Learning Courses (CCC)	--	--	--	--	--	--	1	--	**1**	4	
Comm. Engg. Project(CEP) /Field Project (FP)		--	--	--	--	--	--	--	--	**1**	2	
Project		--	--	--	--	--	1	2	--	**3**	4	16
Internship/ OJT		--	--	--	--	--	--	--	10	**10**	12	
Co-curriculum Courses		--	--	--	1	--	--	--	--	**1**	4	
Compulsory Audit Course (Non-credit)	MAC	--	--	--	--	--	--	--	--	--	--	
Total Credits (Major)		**21**	**21**	**20**	**23**	**23**	**23**	**23**	**22**	**176**	**160-176**	**164-182**

Expected range of credits as per AICTE & NEP2020 guidelines is 160-176)

Sr. No.	Category Suggested	Course Code	No. of Credits	Components %
1.	Humanities and Social Sciences including Management and Environment Courses	HSMEC	3	1.70
2.	Indian Knowledge System	IKS	4	2.27
3.	Ability Enhancement Course	AEC	3	1.70
4.	Value Education Courses	VEC	6	3.41
5.	Basic Science courses	BSC	19	10.80
6.	Engineering Science Courses including workshop, drawing, basics of electrical/mechanical/computer etc.	ESC	24	13.64
7.	Professional Core Courses	PCC	64	36.36
8.	Professional Elective Courses relevant to chosen specialization/branch	PEC	12	6.82
9.	Open subjects – Electives from other technical and /or emerging subjects	OEC	6	3.41
10.	Project, Seminar and Internship	PSI	14	7.95
11.	Project Based Learning	PBL	0	0.00
12.	Vocational and Skill Enhancement Courses	VSEC	5	2.84
13.	Multidisciplinary Minor	MDM	14	7.95
14.	Mandatory Audit Courses [Some other courses Decided at the Institute level but that do not get fit in the credits]	MAC (HSMEC)*	0	0.00
15.	Experiential Learning Courses: Research Methodology	ELC: RM	1	0.57
16.	Co-curriculum Courses	CC	1	0.57
	Total		**176**	**100**

* Please note that most of the courses under HSMEC have been covered under audit courses.

Shivaji University, Kolhapur
School of Engineering and Technology

Final Year B.Tech. (Civil Engineering), Semester- VII, AY 2026-27

Teaching and Evaluation Scheme

S.N.	Category	Code	Course Title	Hours per week			Contact Hours	Credits	Evaluation Scheme	
									Theory	Practical
				L	T	P			ISE:ESE	IE:EE
1.	Program Core Course	PCC 411	Structural Dynamics and Earthquake Engineering	03	-	02	05	04	30:70	00:50
2.	Program Core Course	PCC 412	Water Retaining and Flow Diversion Structures	03	-	-	03	03	30:70	00:00
3.	Humanities Social Science and Management: Entrepreneurship / Economics / Management	HSSM (EEMC 411)	Project Management and Entrepreneurship	03	-	-	03	03	30:70	00:00
4.	Program Elective Course	PEC 411	Program Elective -IV	03	-	-	03	03	30:70	00:00
5.	Open Elective Course	OEC 411	Open Elective -II	03	-	-	03	03	30:70	00:00
6.	Experiential Learning: Project	EL (PR 411)	Major Project Work – II	-	-	04	04	02	00:00	50:100
7.	Experiential Learning: Research Methodology	EL (RM 411)	Research Paper, Publication and IPR	01	-	-	01	01	00:00	50:00
8.	Humanities Social Science and Management: Value Education Course	HSSM (VEC 411)	Green Technology and Sustainability	01	-	-	01	01	-	50:00
9.	Experiential Learning Courses: Internship / On job Training	MDM (ELI 411)	MDM based Industry Internship *	One Month Duration*				03	-	50:50
			Total Hours	17	-	06	**23**	**23**	**500**	**400**

* The MDM based industry Internship to be completed during any winter/summer vacation slots 4th Semester onwards, before 7th Semester commencement.

Course Categories	BSC	ESC	PCC	PEC	MDM	OE	VSEC	HSSM				ELC				CC	Total
								AEC	EEMC	IKS	VEC	RM	CEP/FP	PR	INT/OJT		
Credits	--	--	04	06	03	03	--	--	03	--	01	01	--	02	--	--	23
GR	--	--	04-06	06	02	--	--	--	--	--	--	04	--	04	--	--	22

Shivaji University, Kolhapur
School of Engineering and Technology

Final Year B.Tech. (Civil Engineering), Semester- VIII, AY 2026-27

Teaching and Evaluation Scheme

S.N.	Category	Code	Course Title	Hours per week			Contact Hours	Credits	Evaluation Scheme	
									Theory	Practical
				L	T	P			ISE:ESE	IE:EE
1.	Experiential Learning Courses: Internship / On job Training	ELI 421	Industrial Internship (Follow up by the Program)	Entire Semester to be spent in industry				10	00:00	150:200
2.	Experiential Learning Courses: CEP/FP	ELC (CEP 421)	Structural Design and Drawing	01	-	-	01	01	00:00	50:50
3.	SWAYAM (NPTEL) or any other MOOCs Programme Elective Course	PEC 421	Program Elective – V (Through MOOC*)	03	-	-	03	03	30:70	00:00
4.		PEC 422	Program Elective –VI (Through MOOC *)	03	-	-	03	03	30:70	00:00
5.	Humanities Social Science and Management: Indian Knowledge Systems	HSSM (IKS 411)	Indian Architectural Heritage and Traditional Construction Systems	02	-	-	02	02	30:70	00:00
6.	Humanities Social Science and Management: Value Education Courses	HSSM (VEC 421)	Professional Ethics (Through MOOC)	01	-	-	01	01	00:00	50:00
7.	Experiential Learning Courses: Project	MDMELC (PR 421)	MDM based Mini Project***	-	-	-	-	02	-	50:50
							-	**22**	**300**	**600**
			Total Hours (Other than Internship)	**11**	**-**	**-**	**11**			

*There is an option for End Semester Examination either on respective MOOC platform or at the course teacher's end through the University System.

** Though the course is to be completed online either through course coordinator or via suitable MOOC if any, the ISE will be coordinated by the course incharge and the ESE will be through University system.

*** MDM based Mini Project to be completed during 4th Semester to 8th Semester.

Course Categories	**BSC**	**ESC**	**PCC**	**PEC**	**MDM**	**OE**	**VSEC**	**HSSM**				**ELC**				**CC**	**Total**
								AEC	**EEMC**	**IKS**	**VEC**	**RM**	**CEP/FP**	**PR**	**INT/OJT**		
Credits of Semester VIII	--	--	--	--	02	--	--	--	--	02	01	--	01	--	10	--	**20**
Credits of Semester VIII **Maharashtra GR**	--	--	04-06	6	02	--	--	--	--	--	--	--	--	--	12	--	**20**
Cumulative sum of credits (Sem I to VIII)	19	24	61	21	14	6	5	3	3	4	6	1	1	3	10	01	**176**
GR	14-18	16-12	44-56	20	14	8	8	4	4	2	4	4	2	4	12	04	**160-176**
AICTE	20	20	58	26	18	12	--	--	6	2	--	--	--	16		--	**164-182**

List of Electives:

Specialization	**Structural Engineering**	**Water Resources and Environmental Engineering**	**Construction Management**	**Soil Mechanics**	**Transportation Engineering and Land Planning**
Program Elective -I	Theory of Structures	Municipal Solid Waste Management	Construction Planning & Control	Foundation Engineering	History & Theory of Urban Planning
Program Elective –II	Advanced Structural Analysis	Open Channel Hydraulics and Hydraulic Machines	Human Resource Management in Construction	Soil Exploration and Investigation Techniques	Advanced Transportation Systems
Program Elective –III	Advanced Design of RCC Structures	Integrated Waste Management for a Smart City	Construction Methods and Equipment Management	Rock Engineering	Airport Engineering
Program Elective –IV	Design of Bridges	Advanced Water and Wastewater Treatment	Construction Safety Management	Ground Improvement Techniques	Port, Harbour and Coastal Infrastructure Engineering
Program Elective –V	Prestressed Concrete Design	Air Pollution and Control	Disaster Management and Mitigation Measures	Soil Dynamics and Structures	Railway Engineering
Program Elective –VI **(May vary depending upon availability of MOOC)**	Finite Element Analysis	Ground Water Hydrology	Construction Software	Remote Sensing and GIS for Rural Development	Planning Laws and Regulations

***The elective is offered to a batch of minimum students of 15 or 50% of the strength of the class whichever is less.**

Open Elective is to be chosen from faculty other than that of Major Discipline.

List of Open Electives:

Open Elective – I	Optimization Techniques, Solid Waste Management, Green Building, Development Engineering,
Open Elective – II	Remote Sensing and GIS for Rural Development, Intelligent Transportation Systems, Natural Hazards and It's Mitigation, Finite Element Analysis Air Pollution and Control

SEM – VII

Sr. No.	Final Year B.Tech. Semester VII Pre-revised syllabus	Final Year B.Tech. Semester VII Revised syllabus	Remark
1	Design of RCC Structures-I (Theory and Lab-I)	----	No equivalence. Old course is required to run.
2	Structural Dynamics and Earthquake Engineering (Theory and Lab-II)	Structural Dynamics and Earthquake Engineering	Content revised.
3	Estimating and Costing (Theory and Lab-III)	Estimating, Costing and Valuation	Content revised. Shifted to Sem VI.
4	Water Resources Engineering-II	---	No equivalence. Old course is required to run.
5	Elective-I	----	No equivalence. Old course is required to run.
6.	Major Project Phase-I **$**	---	No equivalence. Old course is required to run.
7.	Internship III	----	No equivalence. Old course is required to run.
8.	Audit Course Introduction to Constitution of India	----	No equivalence. Old course is required to run.
9.	----	Water Retaining and Flow Diversion Structures	Newly introduced credit course.
10.	----	Project Management and Entrepreneurship	Newly introduced credit course.
11.	----	Program Elective -III	Newly introduced credit course.
12.	----	Open Elective-II	Newly introduced credit course.
13.	----	MDM based Industry Internship	Newly introduced as a part of MDM
14.	----	Major Project Work - II	Newly introduced credit course.
15.	----	Research Paper, Publication and IPR	Newly introduced credit course.
16.	----	Green Technology and Sustainability	Newly introduced credit course.

* The MDM based industry Internship to be completed during winter/summer vacation slots 4th Semester onwards, before 7th Semester commencement.

SEM – VIII

Sr. No.	Final Year B.Tech. Semester VIII Pre-revised syllabus	Final Year B.Tech. Semester VIII Revised syllabus	Remark
1.	Design of RCC Structures-II	------	No equivalence. Old course is required to run.
2.	Construction Practices	-----	No equivalence. Old course is required to run.
3.	Town and Country Planning	-----	No equivalence. Old course is required to run.
4.	Elective-II	-----	No equivalence. Old course is required to run.
5.	Open Elective	-----	No equivalence. Old course is required to run.
6.	Major Project-Phase II	------	No equivalence. Old course is required to run.
7.	Audit Course VI Professional Ethics	------	No equivalence. Old course is required to run.
8.	-----	Industrial Internship	Newly introduced credit course.
9.	-----	Structural Design and Drawing	Newly introduced credit course.
10.	-----	Program Elective -III (Through MOOC *)	Newly introduced credit course.
11.	------	Program Elective -IV (Through MOOC *)	Newly introduced credit course.
12.	------	Indian Architectural Heritage and Traditional Construction Systems	Newly introduced credit course.
13.	------	Professional Ethics (Through MOOC)	Newly introduced credit course.
14.	------	MDM Based Mini Project*	Newly introduced credit course as per NEP guidelines.

*MDM based Mini Project to be completed during 4th Semester to 8th Semester.

<table>
<tr><td>Year, Program, Semester</td><td colspan="6">Final Year Civil Engineering, Semester VII</td></tr>
<tr><td>Course Code</td><td colspan="6">PCC 411(L)</td></tr>
<tr><td>Course Category</td><td colspan="6">Professional Core Course</td></tr>
<tr><td>Course title</td><td colspan="6">Structural Dynamics and Earthquake Engineering (Theory)</td></tr>
<tr><td rowspan="2">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td colspan="2">Total Contact Hours</td><td>Total Credits</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td colspan="2">3</td><td>3</td></tr>
<tr><td rowspan="2">Evaluation Scheme</td><td colspan="2">ISE</td><td>ESE</td><td>IE</td><td>EE</td><td>Total</td></tr>
<tr><td colspan="2">30</td><td>70</td><td>--</td><td>--</td><td>100</td></tr>
<tr><td>Pre-requisites (if any)</td><td colspan="6">Engineering Mechanics, Theory of structures</td></tr>
<tr><td>Course Rationale</td><td colspan="6">The course deals with vibration theory of the structures in terms of Structural Dynamics and Earthquake Engineering. The course aims at the appropriate design and construction of buildings in accordance with building codes, which is essential to minimize the damage due to earthquakes.</td></tr>
<tr><td>Course Objectives</td><td colspan="6">1. To understand the fundamentals of seismology, seismic activity in India, earthquake characteristics, seismic zoning, and causes of earthquake damage.
2. To explain and apply vibration theory for structural systems and assess the dynamic response of structures subjected to earthquake loading.
3. To analyze and design building structures for seismic forces using Indian Standard codes, with emphasis on structural form, lateral load–resisting systems, and ductile detailing.
4. To introduce modern aseismic design concepts, including seismic protection devices, retrofitting, and strengthening techniques for existing structures.</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">Upon completion of this course, student should be able to –
1. Explain seismological concepts, earthquake characteristics, seismic activity in India, and analyze earthquake data, seismic zoning, and causes of structural damage.
2. Apply vibration theory and modal analysis techniques to evaluate the dynamic response of single- and multi-degree-of-freedom structural systems using response spectra.
3. Analyze the seismic response of buildings and evaluate seismic forces using IS 1893-2016, considering structural form, irregularities, and lateral load–resisting systems.
4. Design ductile RC structural elements as per codal provisions and evaluate the effectiveness of modern aseismic techniques such as base isolation, seismic dampers, and retrofitting methods.</td></tr>
</table>

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	3	1	1	3	1						1	1
CO 2	1	3	3	3	3	2	2	2	1	2	2	1
CO 3	2		2	3	1	1	1	1				1
CO 4	2	1	2			1					1	1

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	Seismic activities of a region-India, local geology and soil condition, quantification, magnitude, energy and intensity of earthquake. Analysis of earthquake data, seismic zoning, causes of earthquake damage, history of past earthquake	4
II	Vibration Theory Free and forced vibration of single degree, two degree, damping, modal analysis techniques, response spectra.	10
III	Structural form and response to earthquakes, Form of super structure, regular, irregular form of structures, Response of load bearing masonry building and RC building with brick infill lateral load resisting system, guidelines for efficient seismic designs.	6
IV	Concept of Seismic Design, Evaluation of seismic force as per Indian code, lateral load analysis of building.	6
V	Codal Provisions for Ductile Detailing of RC Structures subjected to Seismic Forces Design of Flexural members, Design of columns and frame members subjected to Bending and axial load, Design of joints of frame.	7
VI	New Techniques in Aseismic Design Base Isolation Technique, Seismic dampers, Retrofitting and strengthening of structures.	6
Text Books		
1.	Hosur V.I., “Earthquake Resistant Design of RCC Structures”, Willey Publication	
2.	Paz Mario, “Structural Dynamics”, CBS Publishers and Distributers, 2004	
Reference Books		
1.	Pankaj Agarwal and Shrikhande Manish, “Earthquake Resistant Design of Structures”, Prentice Hall of India, New Delhi, 2006.	
2.	Clough R.W. and Penzien Joseph, “Dynamics of Structures”, McGraw Hill Co.	
3.	Dowrick D.J., “Earthquake Resistant Designs”, John Wiley and Sons	
4.	Lothers J.E., “Design in Structural Steel Vol.-I”, Prentice Hall, New Jersy.	
5.	Gosh S. and Gupta A., “Design of Wind and Earthquake Resistant Reinforced Concrete Buildings”, CRC Press, 2021.	
6.	Grover G.R., “Mechanical Vibrations”, Nem Chand and Bross, Roorkee, 2009.	
7.	Krishna Jai, “Elements of Earthquake Engineering”, South Asian Pub., New Delhi.	
8.	Arya A.S., “Earthquake Resistant”, Design of Masonry and Timber Structures”, Nemchand Publishers,, Roorkee.	
9.	Chopra A.K., “Dynamics of Structures”, Prentice Hall of India Pvt. Ltd., 2006	
10.	Duggal S.K., “Earthquake-Resistant Design of Structures”, Oxford University Press	
11.	Government of Maharashtra Earthquake resistant Design of house guidelines and assessment of damages	
12.	Manual of Earthquake Resistant Non-engineering Construction, University, Roorkee	
Reference Codes		
1.	IS 1893 (Part 1): 2025, Criteria for Earthquake Resistant Design of Structures Part 1 General Provisions and Buildings	
2.	IS 13920: 2016, Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces - Code of Practice	
3.	IS 4326: 2013, Earthquake Resistant Design and Construction of Buildings - Code of Practice	
4.	IS 13827: I993, Improving Earthquake Resistance of Earthen Buildings - Guidelines	
5.	IS 13828: 1993, Improving Earthquake Resistance of Low Strength Masonry Buildings-Guidelines	
6.	IS 13935: 1993, Guidelines for Repair and Seismic Strengthening of Buildings	
Useful web links		

1.	https://nptel.ac.in/courses/105106151
2.	https://onlinecourses.nptel.ac.in/noc24_ce74/course

Year, Program, semester	Final Year Civil Engineering, Semester VII					
Course Code	PCC 411					
Course Category	Professional Core Course					
Course title	**Structural Dynamics and Earthquake Engineering (Practical)**					
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**
	-	-	2	2		1
Evaluation Scheme	**ISE**	**ESE**		**IE**	**EE**	**Total**
	---	---		--	50	50
Pre-requisites (if any)	Engineering Mechanics, Theory of structures					
Course Rationale	The laboratory aims to demonstrate the concept of mode shapes, effect of infill during behavior of earthquake, effect of planar asymmetry and liquefaction of soil.					
Course Objectives	1. Demonstrate effect of soil liquefaction during earthquake shaking. 2. Demonstrate the concept of vibration response to SDOF 3. Demonstrate the concept of vibration response to MDOF 4. Demonstrate the effect of stiffness of the infill provided in the structures.					
Course Outcomes	Upon completion of this course, student should be able to – 1. Understand effect of soil liquefaction during earthquake shaking. 2. Understand the concept of vibration response to SDOF 3. Understand the concept of vibration response to MDOF 4. Understand the effect of stiffness of the wall provided in the structures.					

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	1	1		3	1	1						
CO 2	1	3		3	2							2
CO 3	1	3		3	2							2
CO 4	1	2		3	1							1

Level of Mapping as: Low 1, Moderate 2, High 3

Experiment No.	**Experiment title**
The laboratory work should include the following (Any 8)	
1.	Demonstration of soil liquefaction by using vertical shake table
2.	Dynamics of One-Storied Building Frame (Symmetric) under Harmonic Base Motion
3.	Dynamics of One-Storied Building Frame without Infill Stiffness
4.	Effect of Damping on SDOF System Response
5.	Dynamics of Three-Storied Building Frame under Harmonic Base Motion
6.	Three-Storied Building with Infill under Dynamic Loading
7.	Three-Storied Building without Infill at Ground Floor (Soft Storey Effect)
8.	Three-Storied Building with Infill at Ground Floor (Stiff Storey Effect)
9.	One-Storied Building Frame with Planar Asymmetry under Harmonic Motion
10.	Earthquake-Induced Sloshing in Rectangular Tanks

11.	Demonstration of Soil Liquefaction using vertical shake table
12.	Settlement of Soil under Dynamic Loading
13.	Effect of Confinement and Relative Density on Liquefaction Resistance
	Text Books/manuals
1.	Hosur V.I., “Earthquake Resistant Design of RCC Structures”, Willey Publication.
2.	Paz Mario, “Structural Dynamics”, CBS Publishers and Distributers, 2004.
3.	Earthquake Engineering Lab Manual, IISC, Bangalore

Year, Program, Semester	Final Year Civil Engineering, Semester VII					
Course Code	PCC 412 (L)					
Course Category	Professional Core Course					
Course title	**Water Retaining and Flow Diversion Structures (Theory)**					
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**
	3	-	-	3		3
Evaluation Scheme	**ISE**		**ESE**	**IE**	**EE**	**Total**
	30		70	--	--	100
Pre-requisites (if any)	Fluid Mechanics, Open Channel Hydraulics and Hydraulic Machines, Water Resource Engineering					
Course Rationale	The course mainly deals with different hydraulic structures, their functioning, components, practical application and significance. This course requires the student to know about the basic concepts regarding various dams, their site selection and design of various dams, spillways, river training works					
Course Objectives	1. To understand reservoir planning concepts, storage estimation using mass curves, and reservoir losses. 2. To apply principles of hydraulics and soil mechanics in evaluating forces, seepage, and stability of earthen and gravity dams. 3. To analyze the performance and functional requirements of spillways, outlets, and diversion head works 4. To evaluate canal systems, canal regulatory works, and river training measures based on hydraulic and operational considerations.					
Course Outcomes	Upon completion of this course, student should be able to – 1. Compute reservoir storage capacity and determine control levels using mass curve data and given hydrological inputs. 2. Analyse stability and seepage conditions of earthen and gravity dams as per standard criteria. 3. Select and justify appropriate types of spillways, outlets, and diversion head works for given site conditions and hydraulic parameters. 4. Analyse canal systems, canal regulatory structures, and river training works using sediment theories and hydraulic principles					

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	3	2			1							1
CO 2	3	3	2		1							1
CO 3	3	3	3									1
CO 4	3	3	1									1

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	Reservoir storage Calculations using mass curves, Control levels, silting of reservoirs, control of Losses in reservoirs. **Earthen dam**: Types of earthen dams, Components and their functions, methods of construction of earthen dam, Design criterion, phreatic line, Modes of failure, seepage control measures, Drainage filters, stability of slopes for sudden drawdown steady seepage.	7

II	**Gravity Dams**: Forces acting on dam, Design Criterion-theoretical and practical profile, high and low dam, fixing section of dam, stability analysis, and methods of construction, galleries and joints in dams. Arch dams- Introduction, types only.	7
III	**a) Spillway**: Necessity and functions, components of spillway, different types, factors affecting choice of type of spillway. Elementary hydraulic design, types of energy dissipation arrangements, gates for spillway. **b) Outlets in Dams**: Outlets through concrete and earth dams, different types.	7
IV	**Diversion Head Works**: component parts their functions, types of weirs and barrages, Causes of failure and remedies, Introduction to Theory of seepage- Bligh's creep theory, critical exit gradient, Khosla's theory	7
V	**a) Canals**: Types, alignment, typical sections of canals, balancing depth Kennedy's silt theory, canal lining-purpose, types, selection and economics. **b) C. D. Works**: Necessity, Types. **c) Canal Regulatory Works**: head regulator, cross regulator, canal fall, canal escape, standing wave flume.	6
VI	**River Training Works**: Hydraulics of alluvial rivers, meandering, aggradations and degradation, river training, necessity, river training works and bank protection, various measures and their design and construction principles.	6
Text Books		
1.	Punmia B. C., "Irrigation and water power engineering", Laxmi Publications, New Delhi.	
2.	Garg, S. K., "Irrigation Engineering and Hydraulic Structures", Khanna Publishers Delhi.	
3.	Modi P.N., "Water Resource and Water Power Engineering", Standard Book House.	
Reference Books		
1.	Creager, William P.; Justin, Joel D.; Hinds, Julian., "Engineering for Dams, Volume I, II and III", Published by John Wiley Sons Inc., New York, 1947	
2.	Varshney., "Theory And Design Of Irrigation Structures", Nem Chand Bros	
3.	United States Department Of The Interior Bureau Of Reclamation., "Design of Small Dams Hardcover", United States Government Printing Office	
Useful web links		
1.	https://nptel.ac.in/courses/105105110	

<table>
<tr><td>Year, Program, Semester</td><td colspan="6">Final Year Civil Engineering, Semester VII</td></tr>
<tr><td>Course Code</td><td colspan="6">HSSM (EEMC 411)</td></tr>
<tr><td>Course Category</td><td colspan="6">Humanities Social Science and Management: Entrepreneurship / Economics / Management</td></tr>
<tr><td>Course title</td><td colspan="6">Project Management and Entrepreneurship (Theory)</td></tr>
<tr><td rowspan="2">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td colspan="2">Total Contact Hours</td><td>Total Credits</td></tr>
<tr><td>3</td><td>-</td><td>0</td><td colspan="2">3</td><td>3</td></tr>
<tr><td rowspan="2">Evaluation Scheme</td><td colspan="2">ISE</td><td>ESE</td><td>IE</td><td>EE</td><td>Total</td></tr>
<tr><td colspan="2">30</td><td>70</td><td>--</td><td>--</td><td>100</td></tr>
<tr><td>Pre-requisites (if any)</td><td colspan="6">--</td></tr>
<tr><td>Course Rationale</td><td colspan="6">This course provides students with a comprehensive understanding of the concepts, scope, and importance of entrepreneurship, along with the competencies, traits, and motivational factors required to become successful entrepreneurs. It also familiarizes students with various entrepreneurial development programmes, idea generation techniques, and innovation processes that help identify business opportunities and create value in organizations.</td></tr>
<tr><td>Course Objectives</td><td colspan="6">1. To understand the definitions, concepts and components of Entrepreneurship.
2. Know the importance, structure, significance, resources of Indian economy.
3. Have a clear idea about the area development programmes and its impact.
4. Understand about the using of different methods for Project Management</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">Upon completion of this course, student should be able to –
1. Know the definitions, concepts and components of Entrepreneurship.
2. Know the importance, structure, significance, resources of Indian economy.
3. Students have a clear idea about the area development programs and its impact.
4. Understand about the using of different methods for Project Management</td></tr>
</table>

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	3	1		3	1						1	1
CO 2	1	3		3	3	2	2	2	1	2	2	1
CO 3	2	1		3	1	1	1	1				1
CO 4	2	1	2			1					1	1

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Entrepreneurship**: Entrepreneurship: need, scope , Entrepreneurial competencies traits, Factors affecting entrepreneurial development, Entrepreneurial motivation (Mc Clellend's Achievement motivation theory), conceptual model of entrepreneurship , entrepreneur vs. intrapreneur; Classification of entrepreneurs; Entrepreneurial Development Programmes	7
II	**Entrepreneurial Idea and Innovation**: Introduction to Innovation, Entrepreneurial Idea Generation and Identifying Business Opportunities,	6

	Management skills for Entrepreneurs and managing for Value Creation, Creating and Sustaining Enterprising Model Organizational Effectiveness	
III	**Project Management:** Project management: meaning, scope importance, role of project manager; project life-cycle Project appraisal: Preparation of a real time project feasibility report containing Technical appraisal; Environmental appraisal, Market appraisal (including market survey for forecasting future demand and sales) and Managerial appraisal.	6
IV	**Project Financing:** Project cost estimation working capital requirements, sources of funds, capital budgeting, Risk uncertainty in project evaluation , preparation of projected financial statements viz. Projected balance sheet, projected income statement, projected funds cash flow statements, Preparation of detailed project report, Project finance.	7
V	**Social Entrepreneurship:** Social Sector Perspectives and Social Entrepreneurship, Social Entrepreneurship Opportunities and Successful Models, Social Innovations and Sustainability, Marketing Management for Social Ventures, Risk Management in Social Enterprises, Legal Framework for Social Ventures.	7
VI	**Case Study of successful organization/business house:** Case study of Construction Company, Firm, Consultancy Firm, Engineer and Contractors firm/Company etc	6
Text Books		
1.	Innovation and Entrepreneurship by Drucker, P.F.; Harper and Row	
2.	Business, Entrepreneurship and Management: Rao, V.S.P. ;Vikas	
3.	Text Book of Project Management: Gopalkrishnan, P. and Ramamoorthy, V.E.; McMillan	
Reference Books		
1.	Entrepreneurship: Roy Rajeev; OUP.	
2.	Project Management for Engineering, Business and Technology: Nicholas, J.M., and Steyn, H.; PHI	
3.	Project Management: The Managerial Process: Gray, C.F., Larson, E.W. and Desai, G.V.; MGH	
Useful web links		
1.	https://www.youtube.com/watch?v=UPzEH5Ap19Qlist=PLaGBxvvw_eMXlHRUfO-7GXmICy-AQiL0I	
2.	https://www.youtube.com/watch?v=n8qQQESGYSslist=PLecD98TA83BUftk0cZsZNR1rtCWg1ZJKx	

<table>
<tr><td>Year, Program, Semester</td><td colspan="6">Final Year Civil Engineering, Semester VII</td></tr>
<tr><td>Course Code</td><td colspan="6">PEC 411</td></tr>
<tr><td>Course Category</td><td colspan="6">Program Elective – IV</td></tr>
<tr><td>Course title</td><td colspan="6">Design of Bridges (Theory)</td></tr>
<tr><td rowspan="2">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td colspan="2">Total Contact Hours</td><td>Total Credits</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td colspan="2">3</td><td>3</td></tr>
<tr><td rowspan="2">Evaluation Scheme</td><td colspan="2">ISE</td><td>ESE</td><td>IE</td><td>EE</td><td>Total</td></tr>
<tr><td colspan="2">30</td><td>70</td><td>--</td><td>--</td><td>100</td></tr>
<tr><td>Pre-requisites (if any)</td><td colspan="6">Design of Concrete structures</td></tr>
<tr><td>Course Rationale</td><td colspan="6">Bridge Engineering introduces students to the fundamental concepts of bridge systems, loading, structural behavior, and design philosophy. The course emphasizes the application of relevant IRC and IS codes in the analysis and design of bridge components. It enables students to develop competence in designing safe, economical, and durable bridge structures. The course also provides exposure to practical aspects of bridge construction, inspection, and maintenance.</td></tr>
<tr><td>Course Objectives</td><td colspan="6">1. To introduce the classification, components, and structural behavior of different types of bridges.
2. To understand loads and load combinations acting on bridges as per relevant IRC provisions.
3. To apply IRC and IS codes for the analysis and design of RCC bridge superstructure components such as deck slabs and girders.
4. To develop the ability to design bridge substructure elements (piers, abutments, and foundations) and understand practical aspects such as bearings, expansion joints, construction, inspection, and maintenance.</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">After successful completion of the course, students will be able to:
1. Explain the classification, components, and structural behavior of different types of bridges under various loading conditions.
2. Analyze dead loads, live loads, and other forces acting on bridges using relevant IRC provisions.
3. Apply IRC and IS codes for the analysis and design of RCC bridge superstructure components such as deck slabs and girders.
4. Design bridge substructure elements (piers, abutments, and foundations) and identify the function and importance of bridge accessories such as bearings and expansion joints, including maintenance aspects.</td></tr>
</table>

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	3	2	1	-								1
CO 2	3	3	2	1								1
CO 3	3	3	3	2	1						1	1
CO 4	3	3	3	2	1	1					1	2

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Introduction to Bridges-** Definition and importance of bridges, Classification of bridges, According to function, materials, span, alignment, and deck position, Selection of bridge type and site considerations, Components of a bridge, Superstructure, substructure, foundations, IRC specifications and standards for bridge design, General design philosophy and limit state method	6
II	**Loads and Forces on Bridges-** Dead load and live load, IRC live load classifications (Class AA, 70R, Class A), Impact factor, Wind load, water current forces, buoyancy, Longitudinal forces (braking and traction forces), Earth pressure and seismic forces, Load combinations as per IRC	6
III	**Design of RCC Slab Bridges-** Types of slab bridges, Solid slab bridges, T-beam slab bridges (introduction), Effective span and width of carriageway, Bending moment and shear force calculations, Courbon's , theory (introductory), Design of RCC slab bridge deck, Check for shear and deflection, Design of bearings (brief)	8
IV	**Design of RCC T-Beam and Girder Bridges-** Components of T-beam bridges, Load distribution methods, Design of Longitudinal girders, Cross girders, Design of deck slab, Reinforcement detailing, Introduction to prestressed concrete bridges	8
V	**Substructure Design-** Design of piers and abutments, Loads on substructure, Stability analysis, Overturning, Sliding, Bearing pressure, Design of wing walls and return walls, Introduction to foundations for bridges, Open foundations, Pile foundations, Well foundations (concept only)	6
VI	**Bearings, Expansion Joints and Miscellaneous-** Types of bearings, Elastomeric bearings, Roller and rocker bearings, Design considerations for bearings, Expansion joints, Types and functions, Drainage of bridge deck, Parapets, railings, and crash barriers, Maintenance and inspection of bridges	6
Reference Books		
1.	Raju N. K," Design off Bridges', 5th edition, Oxford and IBH Publishing Co. Pvt.	
2.	T. R. Jagadeesh and M. A. Jayaram, *"*Design of Bridge Structures*", Edition. 2nd*,Publisher. Prentice Hall India Learning Private Limited	
3.	Praveen Nagarajan ,''Design of Concrete Bridges: As per Latest IRC Codes", *Publisher. Wiley.*	
4.	D. J. Victor ,"Essentials of Bridge Engineering",*Oxford and IBH Publishing*	
5.	S. Ponnuswamy, "Bridge Engineering", *McGraw Hill Publiction*	
Reference Codes		
1.	IRC: 5 – General Features of Road Bridges, IRC: 6 – Loads and Stresses, IRC: 21 – RCC Bridges, IRC: 112 – Code of Practice for Concrete Road Bridges,	
2.	IS 456 – 2000- Plain and Reinforced Concrete, Bureau of Indian standard, New Delhi	
3.	IS 1343 – Prestressed Concrete Code, Bureau of Indian standard, New Delhi	
Useful web links		
1.	https://nptel.ac.in/courses/105105216	
2.	https://onlinecourses.nptel.ac.in/noc22_ce63/preview	

<table>
<tr><td>Year, Program, Semester</td><td colspan="5">Final Year Civil Engineering, Semester VII</td></tr>
<tr><td>Course Code</td><td colspan="5">PEC 411</td></tr>
<tr><td>Course Category</td><td colspan="5">Program Elective-IV</td></tr>
<tr><td>Course title</td><td colspan="5">Advanced Water and Wastewater Treatment</td></tr>
<tr><td rowspan="2">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Total Contact Hours</td><td>Total Credits</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>3</td><td>3</td></tr>
<tr><td rowspan="2">Evaluation Scheme</td><td>ISE</td><td>ESE</td><td>IE</td><td>EE</td><td>Total</td></tr>
<tr><td>30</td><td>70</td><td>--</td><td>---</td><td>100</td></tr>
<tr><td>Pre-requisites (if any)</td><td colspan="5">Environmental Engineering</td></tr>
<tr><td>Course Rationale</td><td colspan="5">Especially with the identification of emerging pollutants, the rapid growth of population and industrial activities, and lessening availability of water resources, conventional treatment processes are becoming more challenging. Practitioners in the field need to establish best practices in handling water and wastewater from different sources to combat the modern challenges in the industry. This subject focuses on educating students on how to design advanced water and wastewater treatment processes.</td></tr>
<tr><td>Course Objectives</td><td colspan="5">1. To review and understand conventional water and wastewater treatment processes and explain the need for advanced treatment, wastewater reclamation, and reuse.
2. To understand and apply the principles of reactor kinetics, microbial growth kinetics, settling, filtration, membrane processes, and electrodialysis used in advanced treatment.
3. To analyze physicochemical treatment processes such as ion exchange, adsorption, and chemical precipitation for the removal of contaminants from water and wastewater.
4. To evaluate and apply biological and natural treatment systems including nitrogen and phosphorus removal processes, constructed wetlands, and aquatic treatment systems for sustainable wastewater management.</td></tr>
<tr><td>Course Outcomes</td><td colspan="5">Upon completion of this course, student should be able to –
1. Explain the need for advanced water and wastewater treatment, reclamation and reuse, and the fundamentals of reaction kinetics and reactor design used in treatment systems.
2. Analyze and apply settling, filtration, membrane filtration, and electrodialysis processes for advanced treatment of water and wastewater.
3. Evaluate the performance of ion exchange, adsorption, biological nitrogen and phosphorus removal processes, and design suitable treatment units.
4. Design and assess chemical precipitation, disinfection methods, and constructed wetlands for sustainable wastewater management.</td></tr>
</table>

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3											
CO 2	2					2						
CO 3	1		1				2					
CO 4	2	2	2				2					

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Need and Basics of Advanced Treatment** Review of conventional water wastewater treatment, need for advanced water and wastewater treatment, reclamation and reuse of wastewater, Reactors and reaction kinetics: types of reactions and reaction kinetics, types of reactors and principles of reactor design. Microbial growth kinetics, Modeling suspended and attached growth treatment processes.	7
II	**Settling and Filtration** Types of Settling: Hindered and Compression Settling, Filtration: Design and operation of Dual media filter, head loss calculations for depth filtration Membrane Filtration: Terminology, Process Classification, Membrane configuration, specific membrane problems such as fouling and its control, application of membrane processes Electrodialysis: Theory, Design	7
III	**Ion Exchange and Adsorption** Ion Exchange: Process, Ion exchange resins, exchange capacity, ion exchange chemistry and reactions, Design of ion exchange units, Disposal of concentrate waste streams. Adsorption: types of adsorption, adsorption isotherms, activated carbon adsorption kinetics, analysis and design of adsorption columns.	6
IV	**Biological Removal of Nitrogen and Phosphorous** Forms of nitrogen in wastewater, Suspended growth processes for biological nitrification and denitrification, Processes for biological nitrogen removal, Biological phosphorous removal- Process description, processes for BPR.	6
V	**Chemical Precipitation, Disinfection and Disposal of Contaminants** Nitrogen Removal by Physical and Chemical Processes, Chemical precipitation for removal of phosphorous, Chemical precipitation for removal of heavy metals and dissolved inorganic substances, Removal of Refractory organics, Removal of dissolved inorganic substances, Disinfection of wastewater with ozone, UV disinfection, Ultimate disposal of contaminants.	7
VI	**Constructed Wetland** Constructed wetland and aquatic treatment systems; Types- free water surface constructed wetland, subsurface flow constructed wetlands, vertical flow constructed wetland, selection of plants, removal mechanisms, applications, design procedure for constructed wetlands, Management of constructed wetlands.	6
Text Books		
1.	Metcalf Eddy, Inc., George Tchobanoglous, Franklin., "Wastewater Engineering treatment and reuse", Burton, H. David Stensel, Tata McGraw-Hill Education, 2002	
Reference Books		
1.	W. J. Weber., "Physicochemical processes: for water quality control", Wiley Interscience, 1972	
2.	Soli J. Arceivala and Shyam R. Asolekar., "Wastewater Treatment for Pollution Control", Tata McGraw Hill Education, 2017	
3.	Donald R. Rowe, George Tchobanoglous, and Howard S. Peavy, "Environmental Engineering", McGraw Hill Education.	
4.	Manual on Constructed Wetlands Treatment of Municipal Wastewaters- USEPA, 2000	
5.	Manual on Constructed Wetland as an alternative technology for sewage management in India- CPCB, MoEFCC, Government of India	
Useful web links		
1.	https://nptel.ac.in/courses/126105335	
2.	https://nptel.ac.in/courses/103107212	

Year, Program, Semester	Final Year Civil Engineering, Semester VII				
Course Code	PEC 411				
Course Category	Program Elective -IV				
Course title	**Construction Safety Management (Theory)**				
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**
	3	--	--	3	3
Evaluation Scheme	**ISE**		**ESE**	**IE** / **EE**	**Total**
	30		70	-- / ---	100
Pre-requisites (if any)	Human Resource Management in Construction, Construction Methods and Equipment Management				
Course Rationale	The course deals with elements of safety management.				
Course Objectives	1. To understand construction safety concepts, accident causation, and safety management systems. 2. To apply safety regulations, standards, and risk assessment techniques for hazard control. 3. To analyze construction site activities, equipment operations, and accident data for safety improvement. 4. To evaluate safety performance and develop effective safety management strategies for construction projects.				
Course Outcomes	Upon completion of this course, student should be able to – 1. Identify construction hazards and explain safety concepts using standard safety terminology. 2. Apply safety regulations and perform risk assessment using applicable acts, standards, and Job Safety Analysis (JSA), to recommend appropriate control measures. 3. Analyze construction operations and equipment safety using given site conditions and accident scenarios, and determine causes with suitable preventive measures. 4. evaluate safety performance and propose safety management plans using audit results, safety indicators, and best practices				

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	2	2				1	1					1
CO 2	3	3	2			2	2					1
CO 3	3	3	2			2	2					1
CO 4	3	3	3			2	3					2

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Introduction to Construction Safety** Importance of safety in construction industry, Causes, types, and costs of accidents, Safety terminology: hazard, risk, incident, accident, Safety culture and safety management systems, Roles and responsibilities of stakeholders (client, contractor, engineer)	6
II	**Safety Regulations and Risk Assessment** Overview of safety legislation in India, Factories Act, 1948, Building and Other Construction Workers (BOCW) Act, 1996,Guidelines from Occupational Safety and	7

	Health Administration and International Labour Organization, Hazard identification techniques, Risk assessment methods and Job Safety Analysis (JSA), Hierarchy of risk control measures	
III	**Construction Site Safety Practices** Safety in excavation and trenching, Safety in scaffolding and formwork, Safety in concreting, masonry, and demolition works, Electrical safety and fire protection, Personal Protective Equipment (PPE): types, selection, and usage	7
IV	**Equipment and Machinery Safety** Safety in construction equipment (cranes, hoists, loaders), Lifting operations and rigging safety, Inspection and maintenance of machinery, Accident prevention in equipment handling	6
V	**Safety Management and Accident Analysis** Safety planning and site safety organization, Safety training and awareness programs Accident investigation and reporting methods, Safety audits and inspections, Safety performance indicators (frequency rate, severity rate)	7
VI	**Health, Environment, and Modern Safety Practices** Occupational health hazards (dust, noise, vibration), Environmental aspects and sustainable safety practices, Welfare facilities and first aid, Emergency preparedness and response planning, Safety management systems (e.g., ISO 45001), Modern technologies in safety, Case studies of construction accidents	6
Text Books		
1.	Jha, Kumar Neeraj, Patel, Dilip A., Singh, Amarjit, “Construction Safety Management”, Pearson	
2.	Islam, M. Rashad, “Construction Safety: Health, Practices and OSHA”, McGraw Hil	
3.	Griffith, Alan, Howarth, Tim, “Construction Health and Safety Management”, Routledge	
4.	Rowlinson, Steve (Ed.), “Construction Safety Management Systems”, Routledge	
Reference Books		
1.	Levitt, Raymond Elliot, Samelson, Nancy Morse, “Construction Safety Management”, Wiley	
2.	Bhattacharjee, S. K., “Safety Management in Construction (Principles & Practices)”, Khanna Publishers	
3.	Nehme, Charles, “Construction Safety: Principles, Practices, and Regulations”, Academic Press.	
4.	Joshi, Pratibha, Sharma, Promila, Thakur, T. C., “Occupational Health & Safety of Construction Workers Using Personal Protective Equipment”, Sapna Publications	
5.	International Labour Organization, “Safety and Health in Construction”, ILO Publications	
Useful web links		
1.	http://elearn.psgcas.ac.in/nptel/courses/video/105104161/L27.html	
2.	https://onlinecourses.nptel.ac.in/noc20_mg43/preview	

Year, Program, Semester	Final Year Civil Engineering, Semester VII					
Course Code	PEC 411					
Course Category	Program Elective – IV					
Course title	**Ground Improvement Techniques (Theory)**					
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**
	3	-	-	3		3
Evaluation Scheme	**ISE**	**ESE**		**IE**	**EE**	**Total**
	30	70		--	--	100
Pre-requisites (if any)	Geotechnical Engineering, Foundation Engineering					
Course Rationale	The soils at construction sites are not always totally suitable for supporting physical infrastructure such as buildings, bridges, highways, tunnels and dams. Under these conditions, soil needs to be treated using ground improvement techniques. Similarly, specific types of soil improvement techniques are required in the case of expansive soils and collapsible soil and in the case of earthquake prone areas. The course addresses various ground improvement techniques along with principles, design issues and construction procedures.					
Course Objectives	1. To understand the need of ground improvement techniques. 2. To know about the different techniques involved in densifying the soils 3. To study surface and subsoil drainage parameters 4. To identify site specific appropriate material for ground improvement.					
Course Outcomes	Upon completion of this course, student should be able to – 1. Explain the need and objective of ground improvement techniques. 2. Know different methods that are available for compaction or densifying the soils and identify the type of techniques required for various soils. 3. Choose the suitable technique depending upon the condition of soil and requirements. 4. Applicability of different techniques that are available for improvement.					

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	3	2	2	3	2		1		1		2	2
CO 2	2	3	2	3	2	2	2	2	1	2	2	2
CO 3	2		2	2	2	1	1	2		1		2
CO 4	2	2	2			2	1		1	1		2

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Introduction -** Need for Ground Improvement, Different types of problematic soils, Emerging trends in ground Improvement.	3
II	**Mechanical stabilization -** Shallow and deep compaction requirements, Principles and methods of soil compaction, Shallow compaction and methods.	8

	Properties of compacted soil and compaction control, Deep compaction and Vibratory methods Dynamic compaction.	
III	**Hydraulic modification** - Ground Improvement by drainage, Dewatering methods. Design of dewatering systems, Preloading, Vertical drains, vacuum consolidation, Electro-kinetic dewatering, design and construction methods.	8
IV	**Modification by admixtures and geotextiles** - Cement stabilization and cement columns, Lime stabilization and lime columns. Stabilization using bitumen and emulsions, Stabilization using industrial wastes Construction techniques and applications, Use of Geotextiles in Soil Stabilization – reinforcing soils, improving drainage, separation, filtration, and load distribution.	8
V	**Grouting** - Permeation grouting, compaction grouting, jet grouting, different varieties of grout materials, grouting under difficult conditions.	4
VI	**In situ soil treatment methods** - Soil nailing, rock anchoring, micro-piles, design methods, construction techniques. Case studies Case studies of ground improvement projects.	8
Text Books		
1.	M C. R. Davies, F.Schlosser Ground improvement geosystems.	
2.	Koerner, R. M., Designing with geosynthetics, Prentice Hall Inc. 1998.	
3.	Manfired R. Hausmann, Engineering Principles of Ground Modification, McGraw-Hill Pub, Co., 1990.	
Reference Books		
1.	Principle and Practice of Ground Improvement by Jie Han	
2.	Engineering Principles of Ground Modifications by Manfred R. Hausmann	
3.	Ground Improvement Techniques by P Purushothama Raj	
Useful web links		
1.	https://archive.nptel.ac.in/courses/105/108/105108075/	
2.	https://archive.nptel.ac.in/courses/105/105/105105210/	
3.	https://onlinecourses.nptel.ac.in/noc23_ce78/preview	

Year, Program, Semester	Final Year Civil Engineering, Semester VII					
Course Code	PEC 411(L)					
Course Category	Program Elective -IV					
Course title	**Port, Harbour and Coastal Infrastructure Engineering**					
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**	
	3	-	-	3	3	
Evaluation Scheme	**ISE**	**ESE**		**IE**	**EE**	**Total**
	30	70		---	---	100
Pre-requisites (if any)	Transportation and Land Planning					
Course Rationale	Ports and coastal infrastructure are essential for trade, transportation, and economic development in a maritime country like India. This course introduces the planning, components, and functioning of port and harbour systems along with coastal processes and environmental considerations. It equips students with fundamental knowledge required for careers in coastal, port, and offshore infrastructure sectors.					
Course Objectives	1. To introduce the fundamentals of coastal environment, ports, and harbour systems using standard engineering concepts. 2. To develop understanding of planning principles and functional layout of port and harbour infrastructure. 3. To familiarize students with construction practices, operational systems, and components of port facilities. 4. To create awareness about environmental impacts, maintenance practices, and modern developments in coastal infrastructure.					
Course Outcomes	Upon completion of this course, student should be able to – 1. Explain coastal processes and port components using standard engineering concepts. 2. Apply planning principles for port layout and harbour facilities. 3. Describe construction practices and operational systems in ports. 4. Evaluate environmental and modern development aspects of coastal infrastructure.					

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	3	2					2					1
CO 2	3	3	2				2				1	1
CO 3	2	2			1		1		2	1		1
CO 4	2	2		1		2	3	1		1		2

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Introduction to Ports and Coastal Environment** Importance of ports in infrastructure and economy, Types of vessels and their characteristics, Types of harbours and ports, Coastal environment: waves, tides, currents, storm surge, tsunami, Introduction to coastal zone processes (erosion and accretion), Basic port terminology and components	6
II	**Port Planning and Layout** Principles of port planning, Site selection for ports, Port layout and functional requirements, Harbour layout: basins, entrance, turning circle, Navigation channels and basic considerations, Use of hydrographic charts in port planning	7

III	**Port Structures and Components** Breakwaters: types and functions, Berthing structures: quay walls, jetties, wharves, Fender systems and mooring arrangements, Coastal protection structures: seawalls, groynes, Role and functioning of different structural components	7
IV	**Construction Practices and Port Operations** General construction methods in marine environment, Challenges in coastal and offshore construction, Introduction to construction equipment and methods, Mechanical handling systems (cargo handling, containerization), Port operations: loading, unloading, storage systems	6
V	**Maintenance, Inspection and Environmental Aspects** Common distress in port and coastal structures, Inspection and maintenance practices, Introduction to condition assessment techniques (UPV, half-cell: basic concept only), Environmental Impact Assessment (EIA) for port projects, Coastal pollution and sustainability issues	6
VI	**Modern Developments and Case Studies** Modernization of ports and smart port concepts, Dredging and disposal (basic concepts), Greenfield port development: PPR and DPR overview, Offshore facilities: SBM/SPM and open sea jetties (conceptual), Case studies: Indian ports (e.g., major and minor ports), Effects of tsunami and coastal hazards, Rehabilitation and retrofitting practices	6
	Text Books	
1.	Oza Chartor, “Dock and Harbor Engineering”, Publication House.	
2.	Bindra, S.P., *Dock and Harbour Engineering*, Dhanpat Rai Publications.	
3.	Rangwala, S.C., *Harbour, Dock and Tunnel Engineering*, Charotar Publishing House.	
	Thoresen, C.A., *Port Designer’s Handbook*, ICE Publishing.	
	Reference Books	
1.	Quinn, A.D., *Design and Construction of Ports and Marine Structures*, McGraw Hill..	
2.	Gerwick, B.C. Jr., *Construction of Marine and Offshore Structures*, CRC Press.	
3.	U.S. Army Corps of Engineers, *Coastal Engineering Manual*.	
4.	PIANC, *Guidelines for Port and Harbour Design*.	
5.	Shore Protection Manual, U.S. Army Coastal Engineering Research Center	
	Reference Codes	
1.	IS 4651 Series: Planning and Design of Ports and Harbours	
2.	IS 9527 Series: Design and Construction of Port and Harbour Structures	
3.	IS 3955: Concrete for marine structures	
	Useful web links	
1.	https://nptel.ac.in/courses/114106025	

Year, Program, Semester	Final Year Civil Engineering, Semester VIII					
Course Code	OEC 411 (L)					
Course Category	Open Elective Course II					
Course title	**Remote Sensing and GIS for Rural Development (Theory)**					
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**
	3	-	-	3		3
Evaluation Scheme	**ISE**		**ESE**	**IE**	**EE**	**Total**
	30		70	--	--	100
Pre-requisites (if any)	--					
Course Rationale	Remote Sensing is a technology to gather information and analyze an object or phenomenon without making any physical contact. This technology is used in numerous fields like geography, hydrology, ecology, oceanography, glaciology, geology. The aim of this course to acquaint the students with various applications of remote sensing in Civil Engineering.					
Course Objectives	1. Understand the fundamental concepts of rural development and the significance of water and food security. 2. Explain geospatial technologies (RS GIS) and their role in addressing rural development issues. 3. Demonstrate the use of open-source RS GIS software for handling vector and raster data. 4. Apply RS GIS techniques to analyze, manage, and assess rural resources and development schemes.					
Course Outcomes	Upon completion of this course, student should be able to – 1. Describe key rural development challenges and the linkages to water and food security. 2. Operate open-source GIS software for processing geospatial data relevant to rural environments. 3. Analyze spatial data for applications such as water resources, agriculture, healthcare, and education in rural settings. 4. Evaluate the effectiveness of government rural development schemes using RS GIS tools and present case-based solutions.					

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	2	2	1									
CO 2	2	1	2		3							3
CO 3	2	3	2		2							3
CO 4	1	2	2		2							2

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Introduction to rural development** concepts, issues, and linkages to water and food security, Introduction to geospatial technology (RSGIS) and its importance in rural development	7
II	**Introduction to open-source software** open source software for RS GIS applications, Introduction to GIS: Operations on vector data sets and raster data sets	7

III	**Digital remote sensing image processing**: Georeferencing of map data, cartographic maps, shape file creation, Digital elevation model, land use land cover change analysis	6
IV	**RS GIS for rural water resources management** Surface water management, groundwater management **RS GIS for agriculture and soil management** farm linkages, irrigation, crop management, and mapping of storage infrastructure	7
V	**RS GIS application** Rural healthcare, education, connectivity, and communication RS GIS for impact assessment of government rural development schemes	6
VI	**Case Studies** Applications and examples of RS GIS for rural development: Selected case studies	6
Text Books		
1.	T.M. Lillesand and R.W. Kiefer, "Remote Sensing and Image Interpretation", John Wiley and Sons, New York. 6th edition, 2008	
2.	J.B. Campbell, "Introduction to Remote Sensing", Taylor and Francis, London, 1996	
3.	T. J. M. Kennie and M. C. Mathews, "Remote sensing in Civil Engineering", Surry University press, London, 1985	
Reference Books		
1.	F.F. Sabins, "Remote Sensing: Principles and Interpretation", W.H. Freeman and Company, New York, 1997	
2.	Paul Longley, M.F. Goodchild, "Geographical Information System, Volume I and II", John Wiley and Sons, Inc. 1999.	
3.	Agarwal C.S. and Garg P.K., "Textbook on Remote Sensing in Natural Resources Monitoring and Management", Wheeler Publishing, Allahabad.	
4.	Keith P.B. and Thompson et al., "Remote sensing and water resources management", American Water Resources Association, Urbana Illinois	
5.	Lillesand T.M. and Kiefer R.W., "Remote sensing and Image interpretation", John Wiley and Sons, New York.	
6.	Meijerink M.J., HAM de Brouwer, Mannaerts C.M. and Velenzuela C.R., "Introduction to the use of Geographical Information Systems for Practical hydrology", ITC Publication No. 23, UNESCO, Paris	
Useful web links		
1.	https://nptel.ac.in/courses/105101221	

Year, Program, Semester	Final Year Civil Engineering, Semester VII					
Course Code	OEC 411(L)					
Course Category	Open Elective – II					
Course title	**Intelligent Transportation Systems**					
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**	
	3	-	-	3	3	
Evaluation Scheme	**ISE**	**ESE**		**IE**	**EE**	**Total**
	30	70		---	---	100
Pre-requisites (if any)	Transportation Engineering					
Course Rationale	The course deals with Intelligent Transportation Systems (ITS) use various international (ISO) and national (like India's IRC, AIS) codes and standards for areas like architecture, communication, data management, and specific applications (e.g., vehicle safety, tolling) to ensure interoperability and functionality.					
Course Objectives	1. Learn the objectives, benefits and the telecommunications in ITS. 2. Learn about the functional areas, user needs and services in ITS. 3. Learn the concepts of ITS operations. 4. Learn the applications of ITS.					
Course Outcomes	Upon completion of this course, student should be able to – 1. Understand the advantages of ITS and suggest the appropriate technologies for field conditions. 2. Identify the appropriate system/s in various functional areas of transportation. 3. Know the various systems, plan and implement of ITS. 4. Understand the applications of ITS.					

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	3	3			2					1		2
CO 2	2	2	3		3					1		2
CO 3	3	3	2		2		1			2	1	3
CO 4	2	2	2		3		1			1	1	2

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Introduction to Intelligent Transportation Systems (ITS)** - Definition, Objectives, Historical Background, Benefits of ITS:ITS Data collection techniques, Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.	7
II	**Application oriented systems area** – Advanced public transport system, commercial vehicle operation rural transport system, benefits of ITS. Case Studies on Urban Transportation Plans for medium sized cities; Traffic Forecasting for Highways; Public Transit Demand Forecasting.	7
III	**Telecommunications in ITS** - Information Management, Traffic Management Centres (TMC). Application of sensors to Traffic management; Traffic flow sensor technologies; Transponders and Communication systems; Data fusion at traffic management centres; Sensor plan specification requirements; Elements of Vehicle Location and Route Navigation and Guidance concepts.	6

IV	**ITS functional areas**: Advanced Traffic Management Systems (ATMS) , Advanced Traveller. Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS). ITS User Needs and Services. Travel Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.	7
V	**ITS Operations, Regional and Project ITS architecture**; Concept of operations; ITS Models and Evaluation Methods; Planning human factor issues for ITS, Case studies on deployment planning and system design and operation; ITS safety, ITS security, ITS as a technology deployment program, research, development and business models, ITS planning	6
VI	**ITS applications**: Traffic incident management systems; ITS sustainable mobility, travel demand management, electronic toll collection, ITS road-pricing.; Transportation network operations; commercial vehicle operations ; public transportation applications; Automated Highway Systems- Vehicles in Platoons – ITS in World – Overview of ITS implementations in developed countries, ITS in developing countries.	6
Text Books		
1.	Choudury M. A and Sadek A, “Fundamentals of Intelligent Transportation Systems Planning” Artech House.	
2.	Kan Paul Chen, John Miles, “Recommendations for World Road Association (PIARC)” ITS Hand Book 2000.	
Reference Books		
1.	Sussman, J. M., “Perspective on ITS”, Artech House Publishers, 2005.	
2.	US Department of Transportation, “National ITS Architecture Documentation”, 2007	
3.	Turban. E and Aronson. J. E, “Decision Support Systems and Intelligent Systems”, Prentice Hall	
Reference Codes		
1.	ISO 21217 (2020): Focuses on station and communication architecture for ITS	
2.	ISO/TS 24315-1 (2025): Deals with the management of electronic traffic regulations METR	
3.	IRC: SP: 110-2017**:** An India Road Congress Special Publication on applying ITS in urban areas, covering aspects like incident management, toll collection, and traffic monitoring.	
4.	AIS-140 (India): A standard from India's Automotive Industry Standards Committee for requirements in public transport vehicle operations, including ITS features like tracking and alerts, referencing ISO standards for guidance	
5.	IS/ISO/TR 12859 (2009): Provides guidance on system architecture and privacy in ITS.	
Useful web links		
1.	https://nptel.ac.in/courses/105105204	
2.	http://www.digimat.in/nptel/courses/video/105107210	
3.	http://acl.digimat.in/nptel/courses/video/105105204	

Year, Program, Semester	Final Year Civil Engineering, Semester VII					
Course Code	OEC 411					
Course Category	Open Elective- II					
Course title	**Natural Hazards and Mitigation (Theory)**					
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**
	3	-	-	-		3
Evaluation Scheme	**ISE**		**ESE**	**IE**	**EE**	**Total**
	30		70	--	--	100
Pre-requisites (if any)	---					
Course Rationale	This course introduces students to various natural hazards and their impacts on society and infrastructure. It provides fundamental knowledge of hazard mechanisms, risk assessment, and disaster management concepts. The course emphasizes structural and non-structural mitigation measures for reducing disaster risk. It prepares students to contribute effectively to disaster-resilient planning and sustainable development.					
Course Objectives	After completing this course, students will be able to: 1. To introduce students to different types of natural hazards and their causes. 2. To understand the impact of natural hazards on society, infrastructure, and the environment. 3. To familiarize students with hazard assessment, risk analysis, and disaster management strategies. 4. To develop knowledge of mitigation and preparedness techniques to reduce disaster risk.					
Course Outcomes	After successful completion of the course, students will be able to: 1. Identify and explain different types of natural hazards and their characteristics. 2. Analyze the causes and impacts of natural hazards on built and natural environments. 3. Apply basic methods of hazard assessment and disaster risk evaluation. 4. Recommend appropriate mitigation, preparedness, and management strategies to reduce disaster impacts					

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	3	1				2	2					1
CO 2	2	3		1		3	2					1
CO 3	2	3	1	2	1	2	1					1
CO 4	2	2	3	1		3	2					2

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Introduction to Natural Hazards** Definition and classification of natural hazards, Difference between hazard, disaster, vulnerability, and risk, Types of natural hazards, Geological hazards, Hydro-meteorological hazards, Climatic and biological hazards, Disaster management cycle, Prevention, mitigation, preparedness, response, recovery, Role of engineers in disaster risk reduction	6

II	**Geological Hazards** Earthquakes, Causes and seismic waves, Earthquake measurement (Richter scale, Moment magnitude), Seismic zoning of India, Effects of earthquakes on structures, Earthquake-resistant design principles (introductory), Landslides, Causes and classification, Factors affecting slope stability, Landslide hazard zonation, Mitigation measures for landslides, Volcanic hazards (basic concepts and impacts)	7
III	**Hydro-Meteorological Hazards,** Floods Causes and types (riverine, flash, coastal floods), Flood frequency analysis (basic concept), Flood control and management measures, Cyclones, Formation, characteristics, and impacts, Cyclone-prone regions of India, Structural and non-structural mitigation measures, Droughts, Types and causes, Drought assessment and monitoring, Drought mitigation strategies	7
IV	**Climatic and Environmental Hazards,** Climate change and global warming, Causes and impacts, Extreme weather events, Heat waves and cold waves, Forest fires, Causes, effects, and prevention, Coastal hazards, Tsunamis, Storm surges, Coastal erosion, Mitigation strategies for coastal regions	6
V	**Natural Disaster Mitigation and Management,** Structural mitigation measures, Retrofitting of buildings, Land-use planning, Hazard-resistant construction practices, Non-structural mitigation measures, Early warning systems, Public awareness and education, Disaster preparedness plans, Role of GIS and Remote Sensing in disaster management, Disaster management institutions in India, NDMA, SDMA, NDRF	7
VI	**Case Studies and Risk Reduction,** Major natural disasters in India, Bhuj earthquake, Odisha cyclone, Kerala floods, Indian Ocean tsunami, Lessons learned from past disasters, Community-based disaster management, Sustainable development and disaster resilience, Future challenges in disaster mitigation	6
Reference Books		
1.	*R. B. Singh* – Natural Hazards and Disaster Management, Publisher. Rawat Publications.	
2.	Sharma and Sharma – Disaster Management, Khanna Publishing House.	
3.	Govt. of India – *National Disaster Management Guidelines*	
4.	UNDRR Reports on Disaster Risk Reduction	
Reference Codes		
1.	BIS Codes: IS 1893, IS 4326, IS 13827, IS 13920, Bureau of Indian standard, New Delhi	
Useful web links		
1.	https://nptel.ac.in/courses/105104183	

Year, Program, Semester	Final Year Civil Engineering, Semester VII				
Course Code	OEC 411(L)				
Course Category	Open Elective II				
Course title	**Finite Element Analysis (Theory)**				
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**
	3	-	-	3	3
Evaluation Scheme	**ISE**		**ESE**	**IE** / **EE**	**Total**
	30		70	-- / --	100
Pre-requisites (if any)	--				
Course Rationale	Finite element method is used to solve the complex engineering problems. The applications of finite elements are not limited to only the field of Civil Engineering, but also extended in the field of Mechanical Engineering, Aeronautics and Medical. Hence, the course is included as open elective.				
Course Objectives	1. To understand boundary value problems and variational principles forming the basis of the Finite Element Method. 2. To develop finite element formulations for one-dimensional structural elements such as bars, beams, trusses, and frames. 3. To formulate and analyze two-dimensional scalar field and linear elasticity problems using appropriate elements and numerical integration techniques. 4. To introduce implementation aspects of FEM, including numerical issues and three-dimensional formulations.				
Course Outcomes	Upon completion of this course, student should be able to – 1. Students will be able to derive strong and weak forms of governing equations using variational and weighted residual approaches. 2. Students will be able to formulate and solve finite element models for one-dimensional structural problems. 3. Students will be able to apply finite element techniques to two-dimensional scalar field and elasticity problems and interpret results. 4. Students will be able to understand implementation issues in FEM and extend the formulation to three-dimensional problems.				

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	3	3	–	–	2	–	–	–	–	1	–	2
CO 2	3	3	2	–	2	–	–	–	–	1	–	2
CO 3	2	3	3	–	3	–	1	–	–	1	–	2
CO 4	2	2	2	–	3	–	–	–	–	2	1	3

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	Introduction, Boundary value problems and solution methods, Direct approach – example, advantage and limitations Elements of calculus of variation, Strong form and weak form, equivalence between strong and weak forms, Rayleigh-Ritz method, Method of weighted residuals – Galerkin and Petrov-Galerkin approach; Axially loaded bar, governing equations, discretization, derivation of element equation, assembly, imposition of boundary condition and solution, examples	7

II	Finite element formulation for Euler-Bernoulli beams, Finite element formulation for Timoshenko beams, Finite element formulation for plane trusses and frames computer implementation.	6
III	Finite element formulation for two-dimensional problems - completeness and continuity, different elements (triangular, rectangular, quadrilateral etc.), shape functions, Gauss quadrature technique for numerical integration.	7
IV	Finite element formulation for two-dimensional scalar field problems; Iso-parametric formulation, Application to Heat conduction and torsion problems.	6
V	Finite element formulation for two-dimensional problems in linear elasticity; Formulation, Examples and computer implementation. Implementation issues, locking, reduced integration, B-Bar method.	7
VI	Finite element formulation for three-dimensional problems; Different elements, shape functions, Gauss quadrature in three dimension, examples.	6
Text Books		
1.	Cook R.D., "Concepts and Applications of Finite Element Analysis", John Wiley, New York 1995	
2.	Reddy J.N., "An Introduction to finite element method", Tata McGraw Hill publication, 3rd edition, 2006.	
3.	Desai C.S., "An Introduction to finite element method‖, CBS publication and Distributors, 4th edition, 2011.	
Reference Books		
1.	Bathe K.J., "Finite Element Procedures, Prentice", Hall of India (P) Ltd., New Delhi.	
2.	Belegundu A.D. and Chandrupatla T.R., "Finite Element Methods in Engineering", Prentice hall India, 1991.	
3.	Buchanan G.R., "Finite Element Analysis", McGraw Hill Publications New York 1995	
4.	Chandrupatla T.R. and Belegunda A.D., "Introduction to Finite Elements in Engineering", Prentice Hall India.	
5.	Clough R.W. and Penzien Joseph, "Dynamics of Structures", McGraw Hill Co.	
6.	David Hutton, "Fundamentals of Finite Element Analysis", McGraw-Hill, 2004	
7.	Dawe D. J., "Matrix and Finite Element Displacement Analysis of Structures", Oxford Uni Press, 1984	
8.	Fish J. and Belytschko T., "A First Course in Finite Elements", John Wiley Sons.	
9.	Hughes T.J.R., "The Finite Element Method: Linear Static and Dynamic Finite Element Analysis", Prentice-Hall.	
10.	Reddy J.N, "Finite Element Methods", John Wiley and Sons, 1982	
11.	Seshu P., Textbook of Finite Element Analysis, PHI Learning Private Ltd. New Delhi, 2010.	
Useful web links		
1.	https://onlinecourses.nptel.ac.in/noc22_me43/preview	
2.	https://nptel.ac.in/courses/112105308	
3.	https://nptel.ac.in/courses/112104193	

Year, Program, semester	Final Year Civil Engineering, Semester VII					
Course Code	OEC 411(L)					
Course Category	Open Elective II					
Course title	**Air Pollution and Control (Theory)**					
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**	
	03	-	-	03	03	
Evaluation Scheme	**ISE**	**ESE**		**IE**	**EE**	**Total**
	30	70		--	--	100
Pre-requisites(if any)	Environmental studies, environmental engineering					
Course Rationale	This course provide an understanding of sources of air pollution, their impact on environment and how to control different types of air pollutants along with design of air pollution control devices.					
Course Objectives	1. To provide fundamental knowledge about sources, types, and effects of air pollution, and familiarize students with national and international emission standards. 2. To introduce students to the physics of the atmosphere, meteorological factors influencing air pollutant dispersion, and global effects. 3. To explain the principles and operation of various air pollution control equipment and techniques for emission reduction. 4. To develop skills for assessment and evaluation of air quality (outdoor and indoor) and to formulate strategies for effective air pollution control and mitigation.					
Course Outcomes	Upon completion of this course, student should be able to – 1. Explain the sources, types, and effects of air pollutants, and relevant national and international standards. 2. Interpret meteorological data and atmospheric conditions that affect pollutant dispersion and air quality. 3. Apply and compare various air pollution control technologies and evaluate their suitability for different types of pollutants. 4. Propose effective strategies and solutions for air quality management in outdoor and indoor environments, including automobile emissions and alternative fuels.					

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2				1	2					
CO 2	2	3		2		2	2					
CO 3	2	2	3		2	2	2					
CO 4	1	2	2	2	2	3	3	2	1	2		2

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Fundamentals of Air Pollution** Definition and Sources of Air Pollution, Natural and anthropogenic sources, Types of air pollutants (particulate and gaseous), Effects of Air Pollution on the Biosphere, Impacts on human health, vegetation, animals, and materials	6

II	**Air Pollution Standards, Assessment, and Control Strategies** National and International Air Emission Standards, Air Pollution Emission Inventory & Emission Factors, Air Quality Index (AQI), Strategies for Effective Control of Air Pollution in India, Introduction to Air Pollution Control Act, Overview of International Agreements for Mitigating Global Air Pollution	6
III	**Meteorology and Atmospheric Physics** Structure and Physics of the Atmosphere, Layers, composition, and properties Solar Radiation and Wind Circulation, Lapse Rate, Inversion, and Stability Conditions, Maximum Mixing Depth, Wind Rose, and Plume Behaviour, Global Effects of Air Pollution: Greenhouse effect, acid rain, ozone layer depletion, Heat island effect, visibility, and photochemical reactions	6
IV	**Air Pollutant Control Equipment** Overview, Operation, and Components of Control Devices: Settling chambers, Cyclones, Wet collectors, Fabric filters, Electrostatic precipitators	7
V	**Dispersion of Pollutants and Particulate Matter** Atmospheric Dispersion of Pollutants: Point and line sources, Maximum ground level concentration, Introduction to Gaussian dispersion model, Determination of stack height, Particulate Matter: Definition, distribution, and sources, Terminal settling velocity, Basics of Hood and Duct Design for Particulate Collection	7
VI	**Mobile and Indoor Sources of Air Pollution & Remedial Measures** Motor Vehicle Emissions: Sources and types of automobile pollutants, Photochemical smog, Reduction of emissions (technological and regulatory methods), Alternative fuels and their utilization Indoor Air Pollution: Sources, types, and health impacts, Assessment and evaluation of indoor air quality, Methodology to improve indoor air quality	7
Text Books		
1.	Wark and Warner, “Air Pollution”, C.F., H.R. Publication, 1st Edition, 1978.	
2.	Nevers N., "Air Pollution Control Engineering" McGraw-Hill, New York, 2nd edition, 1995.	
3.	Martin Crawford, “Air Pollution and Control”, Tata McGraw Hill Publication, 1 st Edition, 1976.	
4.	Rao H.V.N. and Rao M. N., "Air Pollution", Tata McGraw Hill, 1st Edition, 1989.	
Reference Books		
1.	Richard W. Boubel and Bruce Turner, "Fundamentals of Air Pollution", Academic Press, New	
2.	Stern A. C., “Air Pollution Vol. I and II”, Allied Publishers Limited, 1 st Edition, 1994.	
Useful web links		
1.	https://nptel.ac.in/courses/105107213	

Year, Program, Semester	Final Year Civil Engineering, Semester VII					
Course Code	EL (PR 411)					
Course Category	Experiential Learning Course: Project					
Course title	**Major Project –II (Project)**					
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**	
	-	-	2	2	2	
Evaluation Scheme	**ISE**	**ESE**		**IE**	**EE**	**Total**
	---	---		50	100	150
Pre-requisites (if any)	The prerequisite for this course is to possess the fundamental knowledge of Civil Engineering					
Course Rationale	The projects help students in different ways like the formation of groups, understanding group behaviour, improving communication skills, learning in-depth within minimum time, interaction with the guide and outside agencies and arriving at the best technical solution.					
Course Objectives	1. To develop students' ability to formulate research objectives and design appropriate methodologies for addressing complex engineering problems. 2. To provide hands-on experience in implementing technical solutions through independent project work. 3. To enhance students' skills in documenting and reporting research progress, results, and future work in a structured and clear manner. 4. To cultivate effective communication and presentation abilities.					
Course Outcomes	1. Formulate clear research objectives and select appropriate methodologies to address the identified research problem. 2. Conduct independent technical work, including data collection, modeling, experimentation, and/or simulation, to generate valid and reliable results. 3. Prepare comprehensive progress reports that clearly communicate the methodology, progress, results, and future work within specified timelines. 4. Present and defend project findings through effective oral and/or poster presentations.					

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	2	3								2		3
CO 2	3	3	2	2	2		2			2		2
CO 3	3	3	2	3	3		2		1	2	1	3
CO 4								2	2	3	1	2
CO 5									3	3		2

Level of Mapping as: Low 1, Moderate 2, High 3

Sr. No.	Course Content
I	The project decided in B. Tech Semester – VI will be continued in B. Tech Semester – VII for further study. Students will be required to: 1. Carry out an extended literature search to review current knowledge, developments in the chosen technical area as well as inconsistencies in the domain. 2. Take on detailed technical work in the chosen area using one or more of theoretical studies, experimental analysis, modeling and simulation using analytical and / or computational methods.

	3. Fabricate progress reports to establish work completed, and to schedule additional work within the time frame specified for the project. 4. Prepare an interim report describing the work done and results obtained. 5. Present the work in a forum involving oral and / or poster presentation on the work done, findings, specific contributions to that field, limitations and future scope. The work to be completed shall consist of: • Literature Review, Research Gap and Content. • Objectives and Motivation. • Research Design, Process, Methodology, Data Collection. • Development and evaluation of links across different areas. • Pre-tests, Results, Discussions, Findings and Limitations.
II	The Internal Continuous Assessment shall be conducted once during the semester. A committee comprising three examiners, including the project guide, nominated by the coordinator, will review the project work once before the finalization of the synopsis. The External Assessment will be conducted at the end of the semester by a committee consisting of one external expert, one faculty member from the department, and the project guide. Students will present their project work before this committee. The committee will evaluate the individual students and award marks accordingly.

Year, Program, Semester	Final Year Civil Engineering, Semester VII				
Course Code	EL (RM 411)				
Course Category	Experiential Learning: Research Methodology				
Course title	**Research Paper, Publication and IPR (Theory)**				
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**
	1	-	-	1	1
Evaluation Scheme	**ISE**		**ESE**	**IE** / **EE**	**Total**
	--		--	50 / --	50
Pre-requisites (if any)	--				
Course Rationale	This course introduces students of all engineering disciplines to the concepts and practices of sustainable development, emphasizing environmentally responsible engineering design and operation. It aims to develop awareness, critical understanding, and innovation for applying green technologies that minimize resource consumption, reduce pollution, and promote circular economy approaches. The course empowers engineers to integrate sustainability principles in diverse fields such as manufacturing, infrastructure, computing, food systems, and communication technologies.				
Course Objectives	1. To introduce the fundamentals of technical writing and scientific communication. 2. To develop skills in preparing research papers and understanding the publication process. 3. To familiarize students with presentation tools and ethical practices in research dissemination. 4. To provide knowledge of Intellectual Property Rights and patent filing procedures.				
Course Outcomes	Upon completion of this course, student should be able to – 1. Explain the fundamentals of technical writing, research documentation, and publication ethics. 2. Apply appropriate tools and formatting guidelines to prepare research manuscripts, posters, and presentations. 3. Analyze the publication process including journal selection, peer review, and ethical issues in research communication. 4. Evaluate intellectual property rights and patent filing procedures for protecting research and innovations.				

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	2	2	1					3		3		2
CO 2	2	2	1	1	3			2	2	2		2
CO 3	2	3	1	2				3	2	3		2
CO 4	1	2	2					3		2	2	2

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Fundamentals of Technical Writing** Basics of technical communication; importance of scientific and technical writing. Types of technical documents such as research papers, project reports, and theses. Structure and components of a technical paper including Abstract, Introduction,	2

	Methods, Results, and Discussion (IMRAD). Principles of clarity, precision, conciseness, and appropriate language usage in scientific writing.	
II	**Ethics in Research and Technical Writing** Ethical issues in research and publication. Plagiarism and its types; data falsification and fabrication; duplicate and multiple submissions. Referencing and citation practices. Academic integrity and responsible conduct in research.	2
III	**Writing for Publication** Selection of appropriate journals and conferences; understanding journal scope, indexing, and impact factor. Manuscript preparation and formatting guidelines. Online submission process and overview of the peer review system. Responding to reviewers' comments and revising manuscripts.	3
IV	**Presentation and Dissemination of Research** Preparation of abstracts, research posters, and oral presentations for conferences and seminars. Best practices for graphical and tabular data representation. Tools for formatting and referencing such as LaTeX, MS Word, EndNote, Mendeley, and Zotero. Collaboration and authorship ethics. Copyright issues and open-access publishing.	3
V	**Introduction to Intellectual Property Rights (IPR)** Concept and need for Intellectual Property Rights. Types of IPR: Patents, Copyrights, Trademarks, Trade Secrets, and Industrial Designs. Basic principles of patentability: novelty, non-obviousness, and utility. National and international IPR organizations such as WIPO and major patent offices. IPR protection mechanisms in India.	3
VI	**Patent Filing and Innovation Management** Patent filing procedures in India and abroad. Patent search using databases such as Google Patents, Espacenet, and WIPO. Basics of patent drafting including claims, specifications, and drawings. Technology transfer and commercialization of intellectual property. Role of incubation centers, innovation ecosystems, and start-up policies.	

Reference Books

1.	M. Ashok Kumar R. Murugesan, Research Methodology and IPR, Charulatha Publications.
2.	R. N. Khandare, Research Methodology IPR, S. Chand Publishing.
3.	Michael Alley, The Craft of Scientific Writing, Springer.
4.	B.L. Wadehra, Law Relating to Intellectual Property, Universal Law Publishing Co.
5.	Deborah E. Bouchoux, Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets, Cengage Learning.
6.	Day Gastel, How to Write and Publish a Scientific Paper, Cambridge University Press.
7.	Robin Jeffery Michael Wilkinson, Publishing Research Successfully, SAGE.

<table>
<tr><td>Year, Program, Semester</td><td colspan="6">Final Year Civil Engineering, Semester VII</td></tr>
<tr><td>Course Code</td><td colspan="6">HSSM (VEC 411)</td></tr>
<tr><td>Course Category</td><td colspan="6">Humanities Social Science and Management: Value Education Course</td></tr>
<tr><td>Course title</td><td colspan="6">Green Technology and Sustainability (Theory)</td></tr>
<tr><td rowspan="2">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td colspan="2">Total Contact Hours</td><td>Total Credits</td></tr>
<tr><td>1</td><td>-</td><td>-</td><td colspan="2">1</td><td>1</td></tr>
<tr><td rowspan="2">Evaluation Scheme</td><td colspan="3">ISE</td><td>ESE</td><td>IE</td><td>EE</td><td>Total</td></tr>
<tr><td colspan="3">--</td><td>--</td><td>50</td><td>--</td><td>50</td></tr>
<tr><td>Pre-requisites (if any)</td><td colspan="6">--</td></tr>
<tr><td>Course Rationale</td><td colspan="6">This course introduces students of all engineering disciplines to the concepts and practices of sustainable development, emphasizing environmentally responsible engineering design and operation. It aims to develop awareness, critical understanding, and innovation for applying green technologies that minimize resource consumption, reduce pollution, and promote circular economy approaches. The course empowers engineers to integrate sustainability principles in diverse fields such as manufacturing, infrastructure, computing, food systems, and communication technologies.</td></tr>
<tr><td>Course Objectives</td><td colspan="6">1. Understand the fundamental concepts of sustainability including environmental, social, and economic dimensions and their relevance to engineering practices.
2. Explain global environmental challenges, resource management issues, and the impact of industrial activities on ecosystems.
3. Apply principles of green engineering, life cycle thinking, and renewable energy technologies to develop sustainable engineering solutions.
4. Analyze and evaluate sustainable systems such as circular economy models, eco-innovation strategies, and environmental assessment tools in real-world engineering contexts.</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">Upon completion of this course, student should be able to –
1. Describe sustainability principles and the Sustainable Development Goals and their relevance to engineering.
2. Analyze environmental challenges related to energy, water, materials, and waste in civil engineering projects.
3. Apply green technologies, renewable energy systems, and life-cycle assessment tools to engineering solutions.
4. Evaluate and propose sustainable and circular solutions for infrastructure systems.</td></tr>
</table>

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	2	1				2	3	1		1		1
CO 2	2	3		1		2	3			1		1
CO 3	2	2	3	1	2	2	3			1	1	2
CO 4	1	3	3	1	1	2	3	1	1	2	1	2

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Sustainability Fundamentals** Definition and dimensions of sustainability (environmental, social, economic), Sustainable Development Goals (SDGs) and their engineering relevance, Principles of green engineering and sustainable innovation	2
II	**Environmental Challenges Resource Management** Global and local environmental issues, Energy, water, and material resource depletion, Waste generation and its impact across industries	2
III	**Green Technologies Eco-Innovation** Concepts and case studies in clean and green technologies, Sustainable materials, cleaner manufacturing, digital sustainability (IoT, AI for energy management), Smart cities, green buildings, and sustainable mobility	3
IV	**Life Cycle Thinking Environmental Assessment** Basics of Life Cycle Assessment (LCA), Carbon and water footprinting, Environmental performance indicators and sustainability metrics	3
V	**Renewable Energy and Sustainable Systems** Solar, wind, hydro, bioenergy, and hydrogen systems, Energy conservation and efficiency improvement, Integration of renewable technologies into engineering design	3
VI	**Circular Economy Sustainable Future** Waste-to-wealth concepts, product stewardship, recycling loops, Ethical, economic, and policy aspects of sustainability, Case studies and communication of sustainability projects	2
Reference Books		
1.	Allen, D.T., Shonnard, D.R. (2001). Green Engineering: Environmentally Conscious Design of Chemical Processes. Prentice Hall, New Jersey.	
2.	Anastas, P.T., Zimmerman, J.B. (2018). The Twelve Principles of Green Chemistry and Engineering. Oxford University Press, Oxford.	
3.	Graedel, T.E., Allenby, B.R. (2010). Industrial Ecology and Sustainable Engineering. Pearson Education, New Jersey.	
4.	Rao, S.S., Parulekar, A.H. (2022). Sustainable Engineering: Concepts, Design, and Case Studies. McGraw-Hill Education, New Delhi.	
5.	Azapagic, A., Perdan, S., Clift, R. (2004). Sustainable Development in Practice: Case Studies for Engineers and Scientists. John Wiley Sons, Chichester.	

<table>
<tr><td>Year, Program, Semester</td><td colspan="7">Multidisciplinary Minor I, 4th Semester onwards</td></tr>
<tr><td>Course Code</td><td colspan="7">MDM 1.4</td></tr>
<tr><td>Course Category</td><td colspan="7">Program Based Internship</td></tr>
<tr><td>Course title</td><td colspan="7">Plumbing Industry Internship</td></tr>
<tr><td rowspan="2">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td colspan="2">Total Contact Hours</td><td colspan="2">Total Credits</td></tr>
<tr><td colspan="4">One Month</td><td colspan="2">03</td></tr>
<tr><td rowspan="2">Evaluation Scheme</td><td colspan="2">ISE</td><td>ESE</td><td>IOE</td><td>IPE</td><td>EOE</td><td>EPE</td><td>Total</td></tr>
<tr><td colspan="2">00</td><td>00</td><td>50</td><td>-</td><td>50</td><td>-</td><td>100</td></tr>
<tr><td>Pre-requisites(if any)</td><td colspan="7">Basics of unit processes and unit operations.</td></tr>
<tr><td>Course Rationale</td><td colspan="7">The Industrial Internship course caters specifically to B.Tech Civil Engineering students pursuing additional specialization through the B.Tech Minor program in areas such as Plumbing Engineering. This course offers practical exposure to industry settings aligned with their chosen sub-specialization, aiming to bridge the gap between theoretical knowledge and practical application. By engaging in a one-month internship, students gain firsthand experience, essential skills, and insights crucial for their future careers in specialized sectors of Civil engineering.</td></tr>
<tr><td>Course Objectives</td><td colspan="7">The course teacher will
1. Help expose students to the 'real' working environment.
2. Promote hands-on experience to the students’ in their related field.
3. Develop synergetic collaboration between industry and the university in promoting a knowledgeable society.
4. Assist in providing the opportunity for students to test their interest in a particular career before permanent commitments are made.
5. Elaborate the dynamic and challenging nature of industrial environments.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">Upon completion of this course, student should be able to
1. Understand industrial processes and operations related to their minor sub-specializations.
2. Apply theoretical concepts to solve practical problems in the industry.
3. Communicate effectively with industry professionals, colleagues, and supervisors.
4. Collaborate efficiently in team environments to complete tasks and projects.
5. Adapt to the dynamic and challenging nature of industrial environments.
6. Reflect on internship experiences for personal and professional growth.</td></tr>
</table>

Course Outcome and Program Outcome Mapping

CO/PO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3											
CO 2		3	2									
CO 3										3		
CO4									3			
CO5						2						3
CO6												2

Level of Mapping as: Low 1, Moderate 2, High 3

Course Content	Hours
The course consists of a one-month internship in a relevant specialized industry. Students will be placed in companies or organizations that align with their chosen sub-specialization within the field of Civil engineering. During the internship, students will engage in various activities, including but not limited to: 1. Shadowing industry professionals to observe and learn about different processes and operations. 2. Assisting with ongoing projects or research initiatives within the organization. 3. Participating in hands-on tasks related to their minor sub-specialization, under the guidance of experienced mentors. 4. Attending training sessions, workshops, and seminars conducted by the industry to enhance their knowledge and skills. 5. Engaging in discussions and meetings with supervisors and colleagues to gain insights into industry practices, challenges, and innovations. 6. Documenting their internship experience through reports, presentations, or reflective journals. The period of one month for this internship will be during the winter or summer vacations, any such slots 4th Semester onwards.	4 weeks

Course Evaluation Method

This particular evaluation will be the part of the structure of 7th Semester.

The evaluation for the Industrial Internship course will be conducted as follows:

- **Internal Evaluation (50 marks):**
    - Assessment by course teachers based on students' performance during the internship, including attendance, participation, attitude, and contribution to assigned tasks.
    - Evaluation by industrial supervisors on students' professional conduct, technical skills, problem-solving abilities, and overall performance in the workplace.
- **External Evaluation (50 marks):**

Evaluation by an external examiner appointed by the institute, who will assess students' internship reports, presentations, or any other documentation submitted at the end of the internship period.

The external examiner will review the quality of students' reflections on their internship experience, their ability to apply theoretical knowledge to practical situations, and the depth of their understanding of industry practices and challenges.

The final grades for the Industrial Internship course will be determined based on the combined assessment from both internal and external evaluations.

Reference Books

1.	India Plumbing Association 2017 Uniform Illustrated Plumbing Code
2.	National Building Code of India – Guidelines for regulating the building construction activities

<table>
<tr><td>Year, Program, Semester</td><td colspan="6">Final Year Civil Engineering, Semester VII</td></tr>
<tr><td>Course Code</td><td colspan="6">ELI 421</td></tr>
<tr><td>Course Category</td><td colspan="6">Experiential Learning Courses: Internship / On job Training</td></tr>
<tr><td>Course title</td><td colspan="6">Industrial Internship</td></tr>
<tr><td rowspan="2">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td colspan="2">Total Contact Hours</td><td>Total Credits</td></tr>
<tr><td colspan="4">Entire Semester to be spent in industry</td><td>10</td></tr>
<tr><td rowspan="2">Evaluation Scheme</td><td colspan="2">ISE</td><td>ESE</td><td>IE</td><td>EE</td><td>Total</td></tr>
<tr><td colspan="2">--</td><td>--</td><td>150</td><td>200</td><td>350</td></tr>
<tr><td>Pre-requisites (if any)</td><td colspan="6">The knowledge of Mini Project, Seminar and Project Management and Entrepreneurship</td></tr>
<tr><td>Course Objectives</td><td colspan="6">The Course is aimed at-
1. Providing exposure to corporate culture.
2. Providing exposure to latest technologies used in the industry.
3. Learning to communicate efficiently.
4. Helping to apply fundamental principles Civil Engineering in real-world problems.</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">Upon completion of this course, student should be able to –
1. Apply fundamental principles of Civil Engineering
2. Identify the latest changes in Civil Engineering Industry.
3. Identify, formulate problems and find engineering solution based on a Practical approach.
4. Create awareness of the social, cultural, global and environmental responsibility as an engineer.</td></tr>
</table>

Course Outcome and Program Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2	2	2	0	0	0	0	0	0	0
CO 2	1	0	3	0	3	0	0	0	0	0	0	3
CO 3	2	3	3	2	2	0	0	0	3	0	2	0
CO 4	0	0	0	0		3	2	3	2	0	0	0

Level of Mapping as: Low 1, Moderate 2, High 3

	Course Content
I	As per the approved academic structure, students have to take internships in the 8th semester of B. Tech program. Below are the guidelines/rules and regulations for the students willing to opt for the internship – • The internship shall be carried out for one full semester in an approved industry, RD organization, startup, or reputed Construction organization. • The internship organization must be approved by the institute/department. • Students must submit an offer letter / confirmation letter before joining. • Follow-up to be taken by one of the faculty member acting as a guide/mentor from the specific program. • Students must strictly follow the rules, regulations, and work ethics of the organization. • Change of internship organization is not permitted without prior written approval from the institute.

	• At the end of the training, the student will submit a report as per the prescribed format to the department. • Submission of Internship Completion Certificate is mandatory. • Failure to complete the internship or submit required documents will result in non-award of credits for the course. **Course Assessment** The student shall make a presentation before a committee constituted by the department which will assess the student based on the report submitted and the presentation made with his/her problem -solving ability, technical competence/skill etc. IE/EE Marks will be awarded and appropriate grades assigned as per the rules and regulations.

Year, Program, Semester	Final Year Civil Engineering, Semester VII				
Course Code	CEP 421				
Course Category	ELC				
Course title	**Structural Design and Drawing (Theory)**				
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**
	1	-	-	1	1
Evaluation Scheme	**ISE**		**ESE**	**IE** / **EE**	**Total**
	---		--	50 / 50	100
Pre-requisites (if any)	Design of Concrete and steel structures				
Course Rationale	This course aims to bridge the gap between structural design and practical construction by developing students' ability to prepare detailed drawings of civil engineering structures. It emphasizes application of codal provisions, standard detailing practices, and professional drawing conventions. The course equips students with skills required for interpretation, preparation, and execution of structural drawings in real-world engineering projects.				
Course Objectives	1. Apply principles of structural design for RCC and steel/masonry elements as per relevant IS codes. 2. Prepare detailed structural drawings using standard drafting conventions and codal requirements. 3. Develop skills in reinforcement and connection detailing for safe and economical construction. 4. Interpret structural drawings and translate design concepts into executable construction details.				
Course Outcomes	After successful completion of the course, students will be able to: 1. Design RCC structural elements such as beams, slabs, columns, and footings using relevant IS codes. 2. Prepare detailed reinforcement drawings with bar bending schedules and sectional details. 3. Design and detail basic steel or masonry structural elements and connections as per codal provisions. 4. Interpret, analyze, and prepare professional structural drawings suitable for construction practices.				

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	3	2	2									
CO 2	2		3		2							
CO 3	3	2	2									
CO 4	2		3		2							

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Design and Drawing of RCC Structural Elements** Design and detailed drawing of RCC beams, slabs (one-way and two-way), lintels and staircases as per IS 456.	1

II	**Design and Drawing of RCC Structural Elements** Preparation of reinforcement detailing including bar bending schedule, cover, anchorage, laps, and sectional detailing with standard drawing conventions.	2
III	**Design and Drawing of RCC Structural Systems** Design and detailed drawing of RCC columns (axially and eccentrically loaded), isolated and combined footings. Structural detailing of beam–column junctions, column footing connections, and plan, elevation, and sectional views following codal provisions.	2
IV	**Design and Drawing of RCC Structural Systems** Design and detail working drawing of RCC buildings or water tank or bridge, etc as per IS 456:2000, IS 1893:2025 and IS 13920:2016.	2
V	**Design and Drawing of Steel Structures** Design and detailed drawing of steel structures such as industrial shade, pedestrian bridge, pre-engineered building, etc as per IS 800:2007	2
VI	**Design and Drawing of Masonry Structures** Design and detailing of load-bearing masonry structures including walls, piers, and foundations as per relevant IS codes.	2
Reference Books		
1.	Layal J.S.“Civil Engineering Drawing” Satya Prakashan	
2.	Kumar N.S.“Civil Engineering Drawing” IPH Publications	
3.	*Malik R.S. Meo G.A.* “Civil Engineering Drawing” – Asian Publishing House	
4.	*Birinder Singh* “Steel Structures Design and Drawing”	
Reference Codes		
1.	IS 456 – 2000- Plain and Reinforced Concrete- Code of practice, Bureau of Indian standard, New Delhi	
2.	IS 13920 – 2000- Ductile Design and Detailing of Reinforced Concrete Structures Subjected to Seismic Forces" Bureau of Indian standard, New Delhi	
3.	IS 800 – 2007- Indian Standard code of practice for general construction in steel, , Bureau of Indian standard, New Delhi	
Useful software’s		
1.	Etabs, SAP2000, StaddPro	

Year, Program, Semester	Final Year Civil Engineering, Semester VII				
Course Code	PEC 421(L)				
Course Category	Program Elective - V (Through MOOC or SWAYAM-NPTEL)				
Course title	**Prestressed Concrete Structures (Theory)**				
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**
	3	-	-	3	3
Evaluation Scheme	**ISE**		**ESE**	**IE** / **EE**	**Total**
	30		70	-- / --	100
Pre-requisites (if any)	Structural Analysis, RCC, Concrete Technology				
Course Rationale	Prestressed concrete is widely used in modern building systems for long-span beams, slabs, parking structures and precast components. Compared to RCC, it offers better serviceability control, crack resistance and structural efficiency. This course develops analytical and design competency of prestressed members as per IS provisions and strengthens preparation for professional practice and competitive examinations.				
Course Objectives	1. To understand the fundamental principles, materials and systems of prestressing. 2. To analyse stresses, losses and deflections in prestressed concrete members. 3. To design prestressed concrete members for flexure, shear and anchorage zones as per IS 1343. 4. To apply prestressing concepts to indeterminate members and modern building applications.				
Course Outcomes	Upon completion of this course, student should be able to – 1. Explain the principles, materials and methods of prestressing. 2. Analyse prestressed concrete sections including computation of losses and service stresses. 3. Design prestressed concrete members for flexure, shear and anchorage zones as per codal provisions. 4. Apply prestressing techniques to continuous members, composite sections and building floor systems.				

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	3	3	2								2	2
CO 2	3	3	3								2	2
CO 3	3	3	3								2	2
CO 4	3	3	3								2	2

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Introduction Basic Concepts** Historical development and need for prestressing, Advantages and limitations over RCC, Pre-tensioning and post-tensioning systems, Materials: high strength concrete and high tensile steel, Stress concept, strength concept and load balancing concept, Cable profiles and pressure line	6

II	**Analysis of Prestressed Sections** Stresses due to prestress and external loads, Straight, eccentric and parabolic tendons, Kern distance and efficiency of sections, Losses of prestress, Deflection of prestressed members	7
III	**Design for Flexure, Shear Anchorage** Design criteria as per IS 1343, Flexural strength of rectangular and I-sections, Limit state design approach, Shear resistance of PSC members, Principal tensile stresses, Transmission length, End block analysis (Guyon's Magnel's methods), Design of anchorage reinforcement	7
IV	**Indeterminate Composite Structures** Continuous prestressed beams, Linear transformation and concordant cable methods, Secondary moments, Composite beams (precast beam + cast-in-situ slab), Partial prestressing concept, Prestressed slabs	6
V	**Building Applications of Prestressed Concrete** Prestressed Floor Systems: Post-tensioned flat slabs, Prestressed beams in multi-storey buildings, Long-span roof systems, Transfer girders Precast Prestressed Components: Hollow core slabs, Precast beams and girders, Prestressed stair flights, Façade panels	7
VI	**Serviceability Modern Trends** Deflection control in PSC members, Crack control criteria, Span-to-depth ratios in buildings, Comparison of RCC and PSC systems, Introduction to bonded and unbonded tendons, Recent developments in prestressed concrete technology	6
Text Books		
1.	Krishna Raju, N., "*Prestressed Concrete"*, Tata McGraw Hill	
2.	Lin, T.Y. Burns, N.H., "*Design of Prestressed Concrete Structures"*, Wiley	
3.	Nawy, E.G., "*Prestressed Concrete: Analysis and Design"*, Pearson	
Reference Books		
1.	Dayaratnam, P., "*Prestressed Concrete Structures"*, Oxford IBH	
2.	Leonhardt, F., "*Prestressed Concrete Design and Construction"*	
Reference Codes		
1.	IS 1343:2012 – Code of Practice for Prestressed Concrete	
2.	Relevant provisions of IS 456	

Year, Program, semester	Final Year Civil Engineering, Semester VII					
Course Code	PEC 421					
Course Category	Program Elective - V (Through MOOC or SWAYAM-NPTEL)					
Course title	**Air Pollution and Control (Theory)**					
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**	
	03	-	-	03	03	
Evaluation Scheme	**ISE**	**ESE**		**IE**	**EE**	**Total**
	30	70		--	--	100
Pre-requisites(if any)	Environmental studies, environmental engineering					
Course Rationale	This course provides an understanding of sources of air pollution, their impact on environment and how to control different types of air pollutants along with design of air pollution control devices.					
Course Objectives	1. To understand the fundamentals of air pollution. 2. To explain atmospheric processes and meteorological factors. 3. To study particulate matter characteristics and air pollution control equipment. 4. To analyse pollutant dispersion, vehicular emissions, and indoor air pollution.					
Course Outcomes	Upon completion of this course, student should be able to – 1. Explain the sources, types, and effects of air pollution on the biosphere. 2. Analyze the influence of meteorological parameters on the dispersion of atmospheric pollutants.) 3. Apply the principles of air pollution control to evaluate the design and operation of particulate control devices. 4. Evaluate and propose suitable mitigation strategies for motor vehicle emissions, indoor air pollution, and other air pollution sources using appropriate control technologies and alternative fuels.					

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2				2	3					2
CO 2	3	3		2	1	2	3					2
CO 3	2	2	3	2	2	2	3				1	2
CO 4	2	3	2	1	2	3	3	1			1	2

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Air pollution** Air pollution: sources and types and effects on biosphere, National and international air emission standards; air pollution emission inventory; emission factor; air quality index; Strategy for effective control of air pollution in India, Introduction to air pollution control act, and international agreements for mitigating global air pollution effects.	7
II	**Meteorology** Physics of atmosphere, Solar radiation, Wind circulation, Lapse rate, Inversion, Stability conditions, Maximum mixing depth, Wind rose, Plume behaviour, Global	7

	effects of air pollution: Greenhouse effects, acid rain and ozone layer depletion, Heat island effect, Visibility, Photochemical reaction	
III	**Air Pollution Control Equipments** Operation and component detailing of Settling chamber, Cyclone, Wet collectors, Fabric filter, and Electrostatic precipitator	6
IV	**Dispersion of pollutants in the atmosphere** Point source, Line source, Maximum ground level concentration, the Gaussian dispersion model, Determination of stack height, Definition, Distribution and source of different particulate matter, Terminal settling velocity, Basics of hood and duct design for particulate collection	7
V	**Motor Vehicle Emissions and remedial measures** Automobile Source, Emission of pollutants from automobiles, Photochemical smog, Reduction of emissions by different methods, Alternative fuels and their utilizations	6
VI	**Indoor air pollution and remedial measures** Sources, types and health impacts. Assessment and evaluation of Indoor air quality, methodology to improve indoor air quality	6
Text Books		
1.	Wark and Warner, “Air Pollution”, C.F., H.R. Publication, 1st Edition, 1978.	
2.	Nevers N., "Air Pollution Control Engineering" McGraw-Hill, New York, 2nd edition, 1995.	
3.	Martin Crawford, “Air Pollution and Control”, Tata McGraw Hill Publication, 1 st Edition, 1976.	
4.	Rao H.V.N. and Rao M. N., "Air Pollution", Tata McGraw Hill, 1st Edition, 1989.	
Reference Books		
1.	Richard W. Boubel and Bruce Turner, "Fundamentals of Air Pollution", Academic Press, New	
2.	Stern A. C., “Air Pollution Vol. I and II”, Allied Publishers Limited, 1 st Edition, 1994.	
Useful web links		
1.	https://nptel.ac.in/courses/105107213	

Year, Program, Semester	Final Year Civil Engineering, Semester VIII					
Course Code	PEC 421					
Course Category	Program Elective - V (Through MOOC or SWAYAM-NPTEL)					
Course title	**Disaster Management and Mitigation Measures**					
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**
	3	-	-	3		3
Evaluation Scheme	**ISE**	**ESE**		**IE**	**EE**	**Total**
	30	70		---	---	100
Pre-requisites (if any)	Environmental Engineering					
Course Rationale	The course deals with disaster management and mitigation is to minimize losses (lives, property, economy, environment) by reducing hazard impacts, enhancing preparedness, ensuring efficient response, and promoting resilient recovery, moving from reactive relief to proactive risk reduction by integrating safety into development, building community capacity, and using technology for early warning and coordination. It's a continuous cycle of preventing, mitigating, and preparing for, responding to, and recovering from disasters to build stronger, safer communities.					
Course Objectives	1. Learn the causes of various disasters and its impact. 2. Learn the concept of Disaster Management Cycle and Framework. 3. Learn the Applications of Science and Technology for Disaster Management Mitigation. 4. Learn the mitigation of disaster.					
Course Outcomes	Upon completion of this course, student should be able to – 1. Understand the disasters, disaster preparedness 2. Apply the mitigation measures. 3. Understand the role of IT, remote sensing, GIS/GPS in risk reduction. 4. Apply knowledge of disaster management acts and guidelines.					

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	2	3			2					1		2
CO 2	3	2	3		3					1		3
CO 3	2	2	2		2		1			1		2
CO 4	3	3	2		3					2	1	3

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	Introduction understanding the concepts and definitions of disaster and its types, hazard, vulnerability, risk, capacity, disaster and development, and disaster management.	4
II	Consequences and control of disasters geological, hydro-meteorological, biological, and technological and man- made disasters, global disaster trends, emerging risks of disasters, climate change and urban disasters.	6
III	Disaster management cycle and framework disaster management cycle, paradigm shift in disaster management pre-disaster risk assessment and analysis, risk mapping, zonation and micro zonation, prevention and mitigation of disasters, early warning system; preparedness, capacity development.	8

IV	Awareness during disaster evacuation, disaster communication, search and rescue, emergency operation centre, incident command system, relief and rehabilitation, damage and needs assessment, restoration of critical infrastructure, early recovery, reconstruction and redevelopment, IDNDR, Yokohama Strategy, Hyogo Framework of Action.	7
V	Disaster management in India disaster profile of India, mega disasters of India and lessons learnt, disaster management act 2005, institutional and financial mechanism, and national policy on disaster management, national guidelines and plans on disaster management, role of government, non-government and inter-governmental agencies.	7
VI	Applications of science and technology for disaster management mitigation geo-informatics in disaster management, disaster communication system, land use planning and development regulations, structural and non-structural mitigation of disasters, and institutions for disaster management in India.	7
Text Books		
1.	Coppola D P, 2007. Introduction to International Disaster Management, Elsevier Science (B/H), London.	
2.	Roy, P.S. (2000): Space Technology for Disaster management: A Remote Sensing GIS Perspective, Indian Institute of Remote Sensing (NRSA) Dehradun.	
3.	H. K. Guptha, Disaster management‖, 2ndEdition, University Press, 2001.	
4.	R. B. Singh (Ed), Disaster Management‖, Rawat Publication, New Delhi, 2000.	
Reference Books		
1.	Manual on natural disaster management in India, M C Gupta, NIDM, New Delhi.	
2.	An overview on natural man-made disasters and their reduction, R K Bhandani, CSIR, New Delhi.	
3.	Disaster Management Act, Publisher by Govt. of India.	
4.	Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management.	
5.	National Disaster Management Policy, GoI	
6.	1. S. Seetharaman, ―Construction Engineering and Management‖, 4th Edition, Umesh publications, New Delhi, 1999 2. 3.	
7.	Gupta, M.C., ―Manuals on Natural Disaster management in India‖, National Centre for Disaster Management, IIPA, New Delhi, 2002.	
8.	Disaster Management Guidelines. GOI-UNDP Disaster Risk Reduction Programme (2009-2012).	
Reference Codes		
Important IS codes related to disaster mitigation include		
1.	IS 1893 (Part 1): Criteria for Earthquake Resistant Design of Structures (General Provisions for Buildings).	
2.	IS 13920: Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces.	
3.	IS 4326: Earthquake Resistant Design and Construction of Buildings: Code of Practice.	
4.	IS 875 (Parts 1-5): Code of Practice for Design Loads (other than earthquake) for Buildings and Structures (e.g., wind loads, snow loads)	
5.	IS 13828: Guidelines for Improving Earthquake Resistance of Low Strength Masonry Buildings.	
6.	IS 13827: Guidelines for Repair and Seismic Strengthening of Buildings: Recommendations for Existing Individual Buildings.	
7.	IS 15496: Guidelines for Improving the Resistance of Rural Housing to Earthquakes.	

Useful web links	
1.	https://www.mooc-list.com/tags/disaster-management#google_vignette
2.	https://onlinecourses.swayam2.ac.in/cec24_hs83/
3.	www.nidmindia.nic.in
4.	http://quake.usgs.gov

Year, Program, Semester	Final Year Civil Engineering, Semester VIII					
Course Code	PEC 421					
Course Category	Program Elective - V (Through MOOC or SWAYAM-NPTEL)					
Course title	**Soil Dynamics and Structures (Theory)**					
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**
	3	-	-	3		3
Evaluation Scheme	**ISE**		**ESE**	**IE**	**EE**	**Total**
	30		70	--	--	100
Pre-requisites (if any)	Soil Mechanics					
Course Rationale	This course provides a fundamental understanding of soil behavior under dynamic and seismic loading conditions. It equips students with knowledge of vibration theory, dynamic soil properties, and wave propagation essential for geotechnical and structural applications. The course emphasizes soil–structure interaction and earthquake engineering concepts required for safe and resilient foundation and structural design.					
Course Objectives	1. Introduce fundamental concepts of soil dynamics and vibration theory relevant to civil engineering structures. 2. Develop understanding of dynamic properties of soils and methods of their evaluation. 3. Explain earthquake engineering principles, seismic response of soils, and soil–structure interaction. 4. Familiarize students with liquefaction, seismic hazards, and basic concepts of earthquake-resistant design.					
Course Outcomes	After successful completion of the course, students will be able to: 1. Explain the basic concepts of soil dynamics, including dynamic properties of soils and wave propagation in soil media. 2. Analyze the response of soil deposits under dynamic loading such as earthquakes, machine vibrations, and impact loads. 3. Evaluate soil–structure interaction effects and the behavior of foundations subjected to dynamic forces. 4. Apply relevant design principles and guidelines for the analysis and design of foundations for machines and structures subjected to dynamic loading.					

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	3	2					1					1
CO 2	3	3	1	2	1		1					1
CO 3	2	3	2	2	1		1					1
CO 4	2	2	3	1	1		2					2

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Introduction to Soil Dynamics-** Definition and scope of soil dynamics. Nature and types of dynamic loads: cyclic, transient, and impact loads. Difference between static and dynamic soil behavior. Stress–strain behavior of soils under dynamic loading. Concept of vibration, degrees of freedom, and basic terminology.	7

II	**Theory of Vibrations-** Free and forced vibrations of single degree of freedom (SDOF) systems with and without damping. Natural frequency, resonance, logarithmic decrement. Response of systems to harmonic, periodic, and impulsive loads. Introduction to multi-degree of freedom (MDOF) systems.	6
III	**Dynamic Properties of Soils-** Dynamic stress–strain relations of soils. Shear modulus, damping ratio, and their variation with strain level. Factors affecting dynamic soil properties. Laboratory and field methods for determination of dynamic properties: cyclic triaxial test, resonant column test, cross-hole and down-hole tests.	7
IV	**Wave Propagation and Machine Foundations-** Types of elastic waves in soils: compression, shear, and surface waves. Wave velocity and attenuation. Introduction to machine foundations. Classification of machines and foundations. Analysis of machine foundations for block type foundations under vertical, horizontal, and rocking vibrations.	7
V	**Earthquake Engineering and Seismic Response-** Causes and characteristics of earthquakes. Seismic waves and their effects. Measurement of earthquakes: magnitude and intensity scales. Response spectra. Seismic response of soil deposits. Site effects and soil amplification. Introduction to seismic zoning and design concepts.	6
VI	**Soil–Structure Interaction and Seismic Design Concepts-** Concept of soil–structure interaction (SSI). Idealization of soil–foundation systems. Effects of SSI on structural response. Liquefaction of soils: mechanism, factors affecting liquefaction, evaluation methods, and mitigation measures. Basic concepts of earthquake-resistant design of foundations and earth structures.	6
Reference Books		
1.	Bharat Bhushan Prasad **,"**Fundamentals of Soil Dynamics and Earthquake Engineering'' – PHI Learning Private Limited.	
2.	Braja M. Das and G.V. Ramana**,** Principles of Soil Dynamics – CL-Engineering or Wadsworth Publishing Co Inc.	
3.	Takaji Kokusho - Innovative Earthquake Soil Dynamics – Taylor and Franci.	
4.	Junbo Jia**, "** Soil Dynamics and Foundation Modeling: Offshore and Earthquake Engineering **–** Springer International Publishing	
Useful links		
1.	https://onlinecourses.nptel.ac.in/noc23_ce41/preview	
2.	https://nptel.ac.in/courses/105101005	

Year, Program, Semester	Final Year Civil Engineering, Semester VIII				
Course Code	PEC 421				
Course Category	Program Elective - V (Through MOOC or SWAYAM-NPTEL)				
Course title	**Railway Engineering**				
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**
	3	-	-	3	3
Evaluation Scheme	**ISE**	**ESE**	**IE**	**EE**	**Total**
	30	70	---	---	100
Pre-requisites (if any)	Traffic Engineering				
Course Rationale	Railway transportation is a key component of national infrastructure, and understanding its fundamentals is essential for civil engineers, particularly in the context of Indian Railways. This course provides knowledge of track components, behaviour, signalling, and maintenance practices required for efficient railway operations. It also prepares students for careers in transportation engineering.				
Course Objectives	1. To introduce fundamentals of railway engineering and permanent way components. 2. To develop understanding of track mechanics, stresses, and rail behavior. 3. To familiarize students with railway signalling, operations, and control systems. 4. To create awareness about maintenance practices and modern railway technologies.				
Course Outcomes	Upon completion of this course, student should be able to – 1. Explain components and functioning of railway track systems. 2. Analyze track behavior and stresses in railway engineering. 3. Describe railway signalling, interlocking, and operations. 4. Evaluate maintenance practices and modern railway technologies.				

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	3	2					1					1
CO 2	3	3	1				1					1
CO 3	2	2			1				2	1		1
CO 4	2	2		1		2	3	1		1		2

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Introduction and Permanent Way** Introduction to railway engineering, Components of permanent way, Gauges and their selection, Wheels and axles, Locomotives and wagons (basic concepts), Rails: sections, length, testing and failures, Sleepers: types, spacing, density, Ballast: functions and types	7
II	**Track Mechanics and Stresses** Traction and resistances, Tractive effort and hauling capacity, Track modulus and stress distribution, Track stresses: vertical, lateral, longitudinal, Stresses in rails, sleepers, and ballast, Formation and subgrade, Rail joints: types and requirements	6
	Rail Joints, Welding and Failures	

III	Types of joints: insulated joints, Welding techniques: alumino-thermit and flash butt welding, Short welded rails, Creep and buckling of rails, Rail wear: causes, measurement, permissible limits, Rail failures and remedial measures	6
IV	**Modern Track Systems and Geometry** Long Welded Rails (LWR) and Continuous Welded Rails (CWR), Rail fastenings (rail-to-rail and rail-to-sleeper), Track alignment: requirements and selection factors, Speed on track: safe and permissible speed, Cant, cant deficiency, cant excess, Transition curves, widening, clearances, Gradients and vertical curves	7
V	**Points, Crossings and Signalling** Turnouts: types and concepts, Crossings and track junctions, Railway signalling: classification and functions, Signal placement, Interlocking: principles and types (mechanical, electrical, electronic), Train control systems: block and non-block systems, Railway stations, yards, level crossings	6
VI	**Track Maintenance and Modern Developments** Track maintenance: methods and criteria, Mechanical and manual maintenance techniques, Maintenance equipment and track machines, Drainage of tracks (surface and subsurface), Track monitoring systems, High-speed rail: technologies and requirements	7
Text Books		
1.	Chandra, S. and Agarwal, M.M., *Railway Engineering*, Oxford University Press.	
2.	Saxea, S.C. and Arora,n S.P., *Railway Engineering*, Dhanpat Rai Publications.	
3.	Agarwal, M.M., *Railway Works Engineering*, McGraw Hill Education.	
4.	Khanna K and Justo C E G, Highway Engineering, Khanna Publishers.	
Reference Books		
1.	Kerr, A.D., *Fundamentals of Railway Track Engineering*, Simmons-Boardman Books.	
2.	Hay, W.W., *Railroad Engineering*, Wiley Publications.	
3.	Mundrey, J.S., *Railway Track Engineering*, Tata McGraw Hill.	
4.	National High Speed Rail Corporation Limited, *India's Bullet Train – The Journey So Far*.	
5.	Rao, G.V., *Basics of Railway Signal Engineering*, Indian Railways Institute of Signal Engineering and Telecommunications.	
Reference Codes		
1.	*Indian Railways Permanent Way Manual*, Indian Railways Institute of Civil Engineering.	
2.	*Indian Railways Signal Engineering Manual*, Indian Railways Institute of Signal Engineering and Telecommunications.	
3.	*Indian Railways Works Manual*.	
4.	*Indian Railways Track Machine Manual*.	
5.	Research Designs and Standards Organisation (RDSO) – IRS Specifications: 1. IRS T-1: Fish Plates 2. IRS T-23: Track Bolts and Nuts 3. IRS T-31: Elastic Rail Clips 4. IRS T-39: PSC Sleepers 5. IRS T-55: Rubber Pads 6. IRS T-59: Composite Sleepers 7. IRST-12: Flat Bottom Rails	
Useful web links		
1.	https://onlinecourses.nptel.ac.in/noc26_ce78/preview	

Year, Program, Semester	Final Year Civil Engineering, Semester VIII				
Course Code	PEC 422(L)				
Course Category	Program Elective - VI (Through MOOC or SWAYAM-NPTEL)				
Course title	**Finite Element Analysis (Theory)**				
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**
	3	-	-	3	3
Evaluation Scheme	**ISE**		**ESE**	**IE** / **EE**	**Total**
	30		70	-- / --	100
Pre-requisites (if any)	--				
Course Rationale	Finite element method is used to solve complex engineering problems. The applications of finite elements are not limited to only the field of Civil Engineering, but also extended in the field of Mechanical Engineering, Aeronautics and Medical. Hence, the course is included as open elective.				
Course Objectives	1. To understand boundary value problems and variational principles forming the basis of the Finite Element Method. 2. To develop finite element formulations for one-dimensional structural elements such as bars, beams, trusses, and frames. 3. To formulate and analyze two-dimensional scalar field and linear elasticity problems using appropriate elements and numerical integration techniques. 4. To introduce implementation aspects of FEM, including numerical issues and three-dimensional formulations.				
Course Outcomes	Upon completion of this course, student should be able to – 1. Students will be able to derive strong and weak forms of governing equations using variational and weighted residual approaches. 2. Students will be able to formulate and solve finite element models for one-dimensional structural problems. 3. Students will be able to apply finite element techniques to two-dimensional scalar field and elasticity problems and interpret results. 4. Students will be able to understand implementation issues in FEM and extend the formulation to three-dimensional problems.				

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	3	3			2					1		2
CO 2	3	3	2		2					1		2
CO 3	2	3	3		3		1			1		2
CO 4	2	2	2		3					2	1	3

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	Introduction, Boundary value problems and solution methods, Direct approach – example, advantage and limitations Elements of calculus of variation, Strong form and weak form, equivalence between strong and weak forms, Rayleigh-Ritz method, Method of weighted residuals – Galerkin and Petrov-Galerkin approach; Axially loaded bar, governing equations, discretization, derivation of element equation, assembly, imposition of boundary condition and solution, examples	9

II	Finite element formulation for Euler-Bernoulli beams, Finite element formulation for Timoshenko beams, Finite element formulation for plane trusses and frames computer implementation.	8
III	Finite element formulation for two-dimensional problems - completeness and continuity, different elements (triangular, rectangular, quadrilateral etc.), shape functions, Gauss quadrature technique for numerical integration.	9
IV	Finite element formulation for two-dimensional scalar field problems; Iso-parametric formulation, Application to Heat conduction and torsion problems.	8
V	Finite element formulation for two-dimensional problems in linear elasticity; Formulation, Examples and computer implementation. Implementation issues, locking, reduced integration, B-Bar method.	9
VI	Finite element formulation for three-dimensional problems; Different elements, shape functions, Gauss quadrature in three dimension, examples.	9

Text Books

1.	Cook R.D., "Concepts and Applications of Finite Element Analysis", John Wiley, New York 1995
2.	Reddy J.N., "An Introduction to finite element method", Tata McGraw Hill publication, 3rd edition, 2006.
3.	Desai C.S., "An Introduction to finite element method‖, CBS publication and Distributors, 4th edition, 2011.

Reference Books

1.	Bathe K.J., "Finite Element Procedures, Prentice", Hall of India (P) Ltd., New Delhi.
2.	Belegundu A.D. and Chandrupatla T.R., "Finite Element Methods in Engineering", Prentice hall India, 1991.
3.	Buchanan G.R., "Finite Element Analysis", McGraw Hill Publications New York 1995
4.	Chandrupatla T.R. and Belegunda A.D., "Introduction to Finite Elements in Engineering", Prentice Hall India.
5.	Clough R.W. and Penzien Joseph, "Dynamics of Structures", McGraw Hill Co.
6.	David Hutton, "Fundamentals of Finite Element Analysis", McGraw-Hill, 2004
7.	Dawe D. J., "Matrix and Finite Element Displacement Analysis of Structures", Oxford Uni Press, 1984
8.	Fish J. and Belytschko T., "A First Course in Finite Elements", John Wiley Sons.
9.	Hughes T.J.R., "The Finite Element Method: Linear Static and Dynamic Finite Element Analysis", Prentice-Hall.
10.	Reddy J.N, "Finite Element Methods", John Wiley and Sons, 1982
11.	Seshu P., Textbook of Finite Element Analysis, PHI Learning Private Ltd. New Delhi, 2010.

Useful web links

1.	https://onlinecourses.nptel.ac.in/noc22_me43/preview
2.	https://nptel.ac.in/courses/112105308
3.	https://nptel.ac.in/courses/112104193

Year, Program, Semester	Final Year Civil Engineering, Semester VIII				
Course Code	PEC 422				
Course Category	Program Elective - VI (Through MOOC or SWAYAM-NPTEL)				
Course title	**Ground Water Hydrology (Theory)**				
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**
	3	-	0	3	3
Evaluation Scheme	**ISE**		**ESE**	**IE** / **EE**	**Total**
	30		70	-- / --	100
Pre-requisites (if any)	Fluid Mechanics, Water Resources Engineering				
Course Rationale	This course will provide an insight into the field of groundwater hydrology. The students will equip themselves with the knowledge of interpretation of groundwater data, conducting the surface and subsurface investigations for the groundwater using the latest methods and tools. The students will be able to learn basic fundamentals of groundwater flow, storage and yield. They will also learn various methods of well development. The concepts of groundwater basin management, conjunctive use, competing demands, recharge and mining will add in equipping students to take better decisions in groundwater management.				
Course Objectives	1. To learn basic fundamentals of groundwater flow. 2. To learn the hydraulics of different kinds of wells. 3. Conjunctive use of ground water along with other fresh water sources. 4. Understand about the using of different methods for Ground Water Management				
Course Outcomes	Upon completion of this course, student should be able to – 1. Understand the basic principles and concepts of groundwater flow in aquifers. 2. Analyze the hydraulics and functioning of different types of wells used for groundwater extraction. 3. Evaluate the concept of conjunctive use of groundwater and surface water for effective water resource utilization. 4. Apply various groundwater management techniques such as recharge methods, conservation practices, and sustainable groundwater development.				

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	3	1		2	1						1	1
CO 2	1	3		2	1	1	1	1	1	2	2	1
CO 3	2	1		3	1	1	1	1				1
CO 4	2	1	2			1					1	1

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Ground Water** Introduction of ground water resources: Global and Indian perspectives Occurrence of ground water Geological factors governing the occurrence of ground water hydraulics of ground water Aquifers and their types and important terms related to ground water Governing equation of ground water flow in aquifers	7
II	**Groundwater well Hydraulics** Geophysical methods in ground water exploration Open wells or dug wells Tube wells Yield of wells and tube wells by Thiem's and Dupuit's equilibrium formula Hydraulics of wells Quality and quantity of ground water and its usefulness in water supply.	7
III	**Salt Water Intrusion** Saline water intrusion Relationship between fresh and saline water Structure of fresh-salt water interface Control of saline water intrusion.	7
IV	**Ground water contamination.** Contaminant transport in groundwater and management Concepts of basin management Equations of hydrologic equilibrium.	6
V	**Ground water management** Groundwater basin investigation Salt balance Basin management by conjunctive use Water harvesting and recharging to aquifers.	6
VI	**Artificial ground water Recharge:** Concept methods of artificial ground water recharge, recharge mounds induced recharge, wastewater recharge for reuse, water spreading.	6
Text Books		
1.	Fetter C.W. (2001) Applied Hydrogeology, Fourth Edition, CBS Publishers and Distributors, New Delhi.	
2.	Raghunath H.M. (2007) Groundwater, 3rd edition, New Age International Publishers.	
3.	Todd D.K. (1980) Groundwater Hydrology, John Wiley and Sons.	
Reference Books		
1.	Fetter C.W. (1990) Applied Hydrogeology, 2nd Edition, CBS Publishers and Distributors, New Delhi.	
2.	McWhorter D.B. and Sundada D.K. (1977) Ground-Water Hydrology and Hydraulics, Water Resources Publications, P.O. Box 303, Fort Collins Colorado, U.S.A.	
3.	Raghunath H.M. (1987) Groundwater, 2nd Edition Wiley Eastern Ltd.	
4.	Rastogi A.K. (2008) Numerical Groundwater Hydrology, Penram International Publishing Pvt. Ltd., Bombay.	
5.	Todd D.K. (1980) Groundwater Hydrology, John Wiley and Sons.	
6.	K. R. Karanth, "Hydrogeology", TataMcGraw Hill Publishing Company.	
7.	S. Ramakrishnan, "Ground water", S. Ramakrishnan.	
Useful web links		
1.	https://youtu.be/3JZb1e_Su3g	
2.	https://www.youtube.com/watch?v=uZGdYsLmklklist=PLLy_2iUCG87BLVJlIwz2d5o1bBif4GAYH	

Year, Program, Semester	Final Year Civil Engineering, Semester VII				
Course Code	PEC 422				
Course Category	Program Elective - VI (Through MOOC or SWAYAM-NPTEL)				
Course title	**Construction Software (Through MOOC) (Theory)**				
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**
	3	--	--	3	3
Evaluation Scheme	**ISE**		**ESE**	**IE** / **EE**	**Total**
	30		70	-- / ---	100
Pre-requisites (if any)	Human Resource Management in Construction, Construction Methods and Equipment Management, Building Construction				
Course Rationale	This course provide computer application for Construction Project management and related activities.				
Course Objectives	1. To learn use of Primavera with reference to different construction activities. 2. To learn M.S. Project for construction management. 3. To understand and learn application of ERP soft wares in Civil Engineering field. 4. To learn project controlling, monitoring and report making with the help of different software's.				
Course Outcomes	Upon completion of this course, student should be able to – 1. To apply Primavera tools for different construction activities. 2. To apply MS Project tools for construction management 3. To apply various techniques from ERP software's for construction related activities. 4. To carry out project controlling, monitoring and report making with the help of different software's.				

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	2	2	1		2	1			1	2	1	1
CO 2	2	2	1		2	1			1	2	1	1
CO 3	2	2	1		2	1			1	2	1	1
CO 4	1	3	1	1	2	1			1	1	1	1

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Introduction To Various Softwares used in Construction:** Use of MS Project management, Promavera, ERP softwares, Need , Importance Career Prospects and Job Roles related to different softwares	7
II	**Primavera -I** Key features, Introduction about Portfolio, Program and Projects, Introduction to Project Management, Introduction to Primavera, History of Planning, Skills required for Planning, Project Phases & Life Cycle, Primavera P6 PPM vs EPPM vs Cloud, Primavera Architecture in detail, Database options in P6	7
III	**Primavera –II** Portfolio Program & Project Structure Creation: Setting up Enterprise Project Structure (EPS), Setting up Organizational Breakdown Structure (OBS), User Administration, User control & Limited Access Provisions, Setting User Preferences, Creating a Project, Defining Project Status, Setting up Project Dates,	7

	Setting up Project Codes, Project Parameters, Project Code and Calendars, Project Time Management, WBS & Activities, Scheduling and Constraints	
IV	**Primavera III** Project Resource management: Project Funding Sources, Activity Costing, Expenses, Estimating Budgeted and Actual cost for Activities, Establishing budgets for Work Packages, Estimating Project Budgets, Preparing Project Cash Flow, Cost Comparison Analysis, Cost Monitoring & Revisions, Project Budget revisions, Project Risk Management, Project Monitoring & Control, schedule comparison, reflections, reporting, Projects	8
V	**MS Project** Key Features, getting started, Task and Schedule Management in Project, Resource and Cost Planning using MS Project, Schedule Tracking and Performance Monitoring, Working with Multiple Projects and External Tools, Customizing Views and Reporting in Microsoft Project, Project Templates and Global Settings	5
VI	**ERP Softwares** What is ERP, roles and benefits, different ERP software's and its key features, Different applications using any one ERP software - Tender & Estimation, Job Costing, Project Budgeting & Forecasting, Contract Management, Subcontractor Management, Procurement & Inventory, Plant & Equipment Management, Financial Accounting, HR & Payroll, Customer Billing, and Supply Chain Portal.	5
Text Books		
1.	P.Vinayagam, A.Vimala, "Planning and Managing Projects with PRIMAVERA (P6) Project Planner", I K International Publishing House	
2.	Rosaldo Nocêra, "Planning and Controlling Civil Construction with MS-Project 2016", Kindle Edition	
Reference Books		
1.	Shannu Aggarwal, "Microsoft Project: A book for all"	
Useful web links		
1.	https://www.coursera.org/professional-certificates/microsoft-project-management	
2.	https://www.oracle.com/in/construction-engineering/primavera-p6/	

Year, Program, Semester	Final Year Civil Engineering, Semester VIII					
Course Code	PEC 422					
Course Category	Program Elective - VI (Through MOOC or SWAYAM-NPTEL)					
Course title	**Remote Sensing and GIS for Rural Development (Theory)**					
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**
	3	-	-	3		3
Evaluation Scheme	**ISE**		**ESE**	**IE**	**EE**	**Total**
	30		70	--	--	100
Pre-requisites (if any)	--					
Course Rationale	Remote Sensing is a technology to gather information and analyzing an object or phenomenon without making any physical contact. This technology is used in numerous fields like geography, hydrology, ecology, oceanography, glaciology, geology. The aim of this course to acquaint the students with various applications of remote sensing in Civil Engineering.					
Course Objectives	1. Understand the fundamental concepts of rural development and the significance of water and food security. 2. Explain geospatial technologies (RS GIS) and their role in addressing rural development issues. 3. Demonstrate the use of open-source RS GIS software for handling vector and raster data. 4. Apply RS GIS techniques to analyze, manage, and assess rural resources and development schemes.					
Course Outcomes	Upon completion of this course, student should be able to – 1. Describe key rural development challenges and the linkages to water and food security. 2. Operate open-source GIS software for processing geospatial data relevant to rural environments. 3. Analyze spatial data for applications such as water resources, agriculture, healthcare, and education in rural settings. 4. Evaluate the effectiveness of government rural development schemes using RS GIS tools and present case-based solutions.					

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	2	2	1									
CO 2	2	1	2		3							3
CO 3	2	3	2		2							3
CO 4	1	2	2		2							2

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Introduction to rural development** concepts, issues, and linkages to water and food security, Introduction to geospatial technology (RSGIS) and its importance in rural development	7
II	**Introduction to open-source software**	6

	open source software for RS GIS applications, Introduction to GIS: Operations on vector data sets and raster data sets	
III	**Digital remote sensing image processing**: Georeferencing of map data, cartographic maps, shape file creation, Digital elevation model, land use land cover change analysis	7
IV	**RS GIS for rural water resources management** Surface water management, groundwater management **RS GIS for agriculture and soil management** farm linkages, irrigation, crop management, and mapping of storage infrastructure	6
V	**RS GIS application** Rural healthcare, education, connectivity, and communication RS GIS for impact assessment of government rural development schemes	7
VI	**Case Studies** Applications and examples of RS GIS for rural development: Selected case studies	6
Text Books		
1.	Basudeb Bhatta, "Remote Sensing and GIS", Oxford University Press, New Delhi, 2nd Edition, 2011.	
2.	M. Anji Reddy, "Remote Sensing and Geographical Information Systems", B. S. Publications, Hyderabad, 4th Edition, 2012.	
3.	Kang-Tsung Chang, "Introduction to Geographic Information Systems", McGraw Hill Education, New York, 8th Edition, 2019.	
4.	C. P. Lo and Albert K. W. Yeung, "Concepts and Techniques of Geographic Information Systems", Prentice Hall of India, New Delhi, 2nd Edition, 2007.	
Reference Books		
1.	T. M. Lillesand, R. W. Kiefer and J. W. Chipman, "Remote Sensing and Image Interpretation", John Wiley & Sons, New York, 7th Edition, 2015.	
2.	Paul A. Longley, Michael F. Goodchild, David J. Maguire and David W. Rhind, "Geographic Information Systems and Science", John Wiley & Sons, UK, 4th Edition, 2015.	
3.	Ian Heywood, Sarah Cornelius and Steve Carver, "An Introduction to Geographical Information Systems", Pearson Education, Harlow, 4th Edition, 2011.	
4.	George Joseph, "Fundamentals of Remote Sensing", Universities Press, Hyderabad, 2nd Edition, 2005.	
5.	N. R. Patel and V. K. Dadhwal, "Remote Sensing and GIS Applications in Agriculture", Indian Agricultural Research Institute, New Delhi, 2013.	
6.	Michael N. DeMers, "Fundamentals of Geographic Information Systems", Wiley India Pvt. Ltd., New Delhi, 4th Edition, 2009.	
Useful web links		
1.	https://nptel.ac.in/courses/105104222	
2.	https://nptel.ac.in/courses/105104203	

Year, Program, Semester	Final Year Civil Engineering, Semester VIII					
Course Code	PEC 422					
Course Category	Program Elective - VI (Through MOOC or SWAYAM-NPTEL)					
Course title	**Planning Law and Regulations**					
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**
	3	-	-	3		3
Evaluation Scheme	**ISE**	**ESE**		**IE**	**EE**	**Total**
	30	70		---	---	100
Pre-requisites (if any)	Town Planning					
Course Rationale	The course deals with Laws in relation to planning (or planning law) are comprehensive rules governing land use and development, balancing private property rights with public interest in orderly growth, public health, and aesthetics, involving procedural steps like public consultation and enforcement mechanisms for unauthorised development, with specific acts like the Maharashtra Regional and Town Planning Act, 1966 (MRTP Act) in India forming the backbone, alongside various other state-level acts for urban management, zoning, and development control.					
Course Objectives	1. To understand the principles of planning, land use, zoning, and the legal framework governing civil engineering projects. 2. To analyze statutory requirements, building codes, and regulatory frameworks to ensure legal compliance in construction projects. 3. To apply planning laws, land acquisition procedures, building regulations, and environmental requirements in real civil engineering scenarios. 4. To evaluate legal and regulatory aspects of projects, contractual obligations, and dispute resolution methods to ensure safe and compliant project execution.					
Course Outcomes	Upon completion of this course, student should be able to – 1. Explain the principles of planning, land use, zoning, and the role of planning authorities in civil engineering projects with correct identification of relevant statutes. 2. Analyze town planning laws, development control regulations (DCR), building codes, and environmental regulations to identify compliance requirements for a given construction scenario. 3. Apply land acquisition procedures, building approval processes, RERA provisions, CRZ regulations, and environmental impact assessments to propose legally compliant project solutions. 4. Evaluate contractual obligations, dispute resolution options, ethical responsibilities, and public participation mechanisms to assess the legal and regulatory compliance of civil engineering projects.					

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	2	2				2	2			1		1
CO 2	2	3	2		1	2	2			2		1
CO 3	3	3	3		2	2	2	1		2	2	2
CO 4	2	3	2		2	3	3	3	2	3	2	2

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Introduction to Planning and Laws in Civil Engineering** Importance of planning and regulatory compliance in civil engineering, Types of planning: urban, regional, and rural, Overview of land use, zoning, and development plans, Sources of planning law: statutes, municipal laws, government regulations, Role of planning authorities and agencies	6
II	**Land Acquisition, Ownership, and Transfer** Land tenure, ownership, and property rights, Land acquisition laws in India (Right to Fair Compensation and Transparency in Land Acquisition Act, 2013), Sale, lease, and transfer of land for civil projects, Encumbrances and easements affecting construction, Legal documentation and title verification	7
III	**Town and Country Planning Laws** Overview of Town and Country Planning Acts (state-specific examples), Development control regulations (DCR), Zoning regulations: residential, commercial, industrial, public use, Floor area ratio (FAR), setbacks, building height, and coverage regulations, Permissions and sanctions for development	6
IV	**Building Regulations and Codes** National Building Code of India (NBC) and its relevance, Building bye-laws: objectives, scope, and enforcement, RERA (Real Estate Regulation) - Introduction to Real Estate (Regulation and Development) Act, 2016, RERA – Financial and Legal Provisions, UDCPR – Planning and Building Regulations, Structural safety requirements, fire safety regulations, Accessibility standards, green building norms, and sustainability requirements, Legal procedures for plan approvals and occupancy certificates	7
V	**Infrastructure Regulations** Coastal Regulation Zone (CRZ) regulations, Infrastructure-related laws: roads, bridges, water supply, sewage systems, Legal compliance for infrastructure projects and environmental impact assessments (EIA)	6
VI	**Legal Aspects of Project Management and Dispute Resolution** Contracts, agreements, and standard bidding procedures, Building approval process and layout permissions, Role of planning authorities, Online approval systems and ease of doing business, Contractual obligations and liabilities of engineers and contractors, Legal remedies in construction disputes: arbitration, conciliation, and litigation, Professional ethics and responsibilities of civil engineers, Case studies of legal challenges in planning and construction, Public participation and transparency	7
Text Books		
1.	Sharma, Brij Kishore, “Town Planning Law and Regulations”, S. Chand & Co.	
2.	Singh, S. K., “Urban and Regional Planning in India”, Vikas Publishing House	
3.	National Building Code of India (Bureau of Indian Standards, latest edition)	
4.	Chandra, R., “Environmental and Legal Aspects of Civil Engineering”, McGraw Hill	
5.	Rao, C. N., “Land Use Planning and Development Control”, Universities Press	
6.	Government of India, “Right to Fair Compensation and Transparency in Land Acquisition Act, 2013”	
7.	Planning Law and Practice By J. Cameron Blackhall, 1st Edition, Imprint Rout ledge-Cavendish	
8.	RERA: Real Estate Regulation Act, 2016 by Vinod Kothari	
9.	Unified Development Control and Promotion Regulations (UDCPR) Manual	
Reference Books		

1.	The Maharashtra Regional And Town Planning Act, 1966
2.	Nelson Petrie, 2016, Analysis and Interpretation of Topographical Maps, The Orient Blackswan, India. 2. 3. 4. 5. 6. 7.
3.	URDPFI guidelines, 2016, Ministry of Housing and Urban Development.
4.	Census of India publications, Govt. of India.
5.	Revised Master Plan 2016, Bangalore Development Authority, 2006.
6.	Revised Master Plan 2031 draft, Bangalore Development Authority, 2017.
7.	Gallion A B, 2005, The Urban Pattern: City Planning Design, CBS publications, 5 th Edition.
8.	Ashok Kumar, et.al, 2020, City planning in India: 1947-2017, Routledge.
9.	Housing and Urban Development by B. K. Sarkar
Useful web links	
1.	http://www.digimat.in/nptel/courses/video/124107158/L35.html
2.	https://www.youtube.com/watch?v=tsmByPHQedA

Year, Program, Semester	Final Year Civil Engineering, Semester VIII					
Course Code	HSSM (IKS 411)					
Course Category	Humanities Social Science and Management: Indian Knowledge Systems					
Course title	**Indian Architectural Heritage and Traditional Construction Systems**					
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**	**Total Credits**	
	2	-	-	2	2	
Evaluation Scheme	**ISE**	**ESE**		**IE**	**EE**	**Total**
	30	70		---	---	100
Pre-requisites (if any)	Fundamental Civil Engineering, Town Planning					
Course Rationale	Ancient Indian structures demonstrate remarkable achievements in civil engineering, materials technology, structural systems, and water management. Civilizations such as Harappa and Mohenjo-daro showcase advanced urban planning, drainage systems, and brick construction, while historical monuments, temples, forts, and dams illustrate sophisticated masonry techniques, lime mortar technology, dome construction, and hydraulic engineering. These traditional systems exhibit exceptional durability and sustainability, often outperforming many modern structures. Studying these systems helps civil engineering students appreciate indigenous construction knowledge and its relevance for sustainable infrastructure development.					
Course Objectives	1. To introduce Indian Knowledge Systems (IKS) and their relevance to civil engineering and construction practices. 2. To understand urban planning, drainage systems, and construction technology of ancient civilizations such as Harappa and Mohenjo-daro. 3. To study structural systems and constructional features of temples, forts, domes, and monumental structures. 4. To evaluate traditional materials, water management systems, and durability aspects of ancient structures for sustainable modern construction					
Course Outcomes	Upon completion of this course, student should be able to – 1. Explain the civil engineering knowledge embedded in ancient Indian construction systems. 2. Describe urban planning, drainage systems and construction technology of Harappa and Mohenjo-daro civilization. 3. Analyze structural systems used in temples, domes, forts and monumental structures. 4. Evaluate durability, sustainability and water management practices in ancient Indian structures.					

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	3	2				1	2	1		1		2
CO 2	3	3	1				3	1	1	1		2
CO 3	3	2	2	1			2	1	1	1	1	2
CO 4	2	3	2	1		2	3	2	1	1	1	3

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Indian Knowledge System and Ancient Civil Engineering** Introduction to Indian Knowledge System in construction and architecture, Evolution of Indian architecture from Indus Valley Civilization to medieval period, Civil engineering aspects of Harappa and Mohenjo-daro: Grid pattern town planning, Standardized brick construction, Underground drainage system, Water supply wells and bathing tanks, Storm water drainage system, Ancient construction materials: brick, stone, lime mortar, timber**,** Case Study: Radhanagari Dam: Construction using stone masonry, Lime mortar preparation and properties, Hydraulic functioning of automatic gate system	5
II	**Constructional Features of Religious Structures:** Structural planning of temples, mosques, churches, monasteries and prayer halls, Temple components: foundation, plinth, mandapa, pillars, shikhara, garbhagriha, Structural features of arches, domes and minarets in mosques, Structural planning of churches and monasteries, Materials used in ancient religious buildings: stone masonry and lime mortar, Case Studies: Konark Sun Temple – solar alignment and stone construction, Brihadeeswara Temple – massive granite structural system, Kopeshwar Temple – circular mandapa and pillar load transfer	4
III	**Structural Engineering in Ancient Monuments:** Load-bearing structural systems in ancient buildings, Masonry construction techniques and bonding patterns, Construction of domes, arches and vaults, Structural load transfer mechanisms in stone structures, Acoustic engineering in domes, Case Studies: Gol Gumbaz – large dome structural system, Taj Mahal – foundation system and marble dome construction	4
IV	**Fort Engineering and Defensive Architecture:** Planning and construction of ancient forts, Structural features: ramparts, bastions, gateways, watch towers and moats, Strategic use of topography and natural rock foundations, Materials and construction techniques used in fort structures, Case Study: Daulatabad Fort – hill fort engineering and defensive mechanism	4
V	**Ancient Water Management and Hydraulic Engineering:** Traditional water supply systems in ancient cities, Step wells, tanks, canals and reservoirs, Construction techniques used in ancient dams, Irrigation systems in early Indian civilizations, Drainage systems used in ancient settlements, Case Study: Kallanai Dam – one of the oldest functioning dams and irrigation structures	4
VI	**Durability and Sustainability of Ancient Structures:** Reasons for long durability of ancient structures, Performance of lime mortar compared to cement mortar, Advantages of load-bearing masonry structures without steel reinforcement, Resistance of traditional structures to weathering and environmental effects, Climate-responsive architecture and passive cooling systems, Comparison between ancient and modern construction practices	5
Text Books		
1.	Percy Brown, “Indian Architecture (Buddhist and Hindu Periods)”, D. B. Taraporevala Sons & Co. Pvt. Ltd., Mumbai, 5th Edition, 1965.	
2.	Percy Brown, “Indian Architecture (Islamic Period)”, Taraporevala’s Treasure House of Books, Mumbai, 3rd Edition, 1964.	
3.	Satish Grover, “Buddhist and Hindu Architecture in India”, CBS Publishers & Distributors Pvt. Ltd., New Delhi, 1st Edition, 2013.	
4.	Satish Grover, “Islamic Architecture in India”, CBS Publishers & Distributors Pvt. Ltd., New Delhi, 1st Edition, 2013.	
Reference Books		

1.	Christopher Tadgell, “The History of Architecture in India: From the Dawn of Civilization to the End of the Raj”, Longman Group UK Ltd., London, 1990.
2.	George Michell, “The Hindu Temple: An Introduction to Its Meaning and Forms”, University of Chicago Press, Chicago, 1988.
3.	Adam Hardy, “Indian Temple Architecture: Form and Transformation”, Abhinav Publications, New Delhi, 2007.
4.	D. P. Agrawal, “Ancient Indian Engineering and Technology”, Aryan Books International, New Delhi, 2000.
5.	Gregory L. Possehl, “The Indus Civilization: A Contemporary Perspective”, Rowman Altamira Publishers, Lanham, Maryland, 2002.
6.	Yatin Pandya, “Concepts of Space in Traditional Indian Architecture”, Mapin Publishing Pvt. Ltd., Ahmedabad, 2005.
Useful web links	
1.	https://asi.nic.in
2.	https://whc.unesco.org
3.	https://civilspedia.com/indus-valley-architecture/
4.	https://www.insightsonindia.com/indian-heritage-culture/architecture/indus-civilization/
5.	http://nmma.nic.in
6.	https://www.intach.org
7.	https://www.iitk.ac.in/nicee
8.	https://www.asi.nic.in/publications/

<table>
<tr><td>Year, Program, Semester</td><td colspan="6">Final Year Civil Engineering, Semester VII</td></tr>
<tr><td>Course Code</td><td colspan="6">HSSM (VEC 421)</td></tr>
<tr><td>Course Category</td><td colspan="6">Humanities Social Science and Management: Value Education Courses</td></tr>
<tr><td>Course title</td><td colspan="6">Professional Ethics (Theory)</td></tr>
<tr><td rowspan="2">Teaching Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td colspan="2">Total Contact Hours</td><td>Total Credits</td></tr>
<tr><td>1</td><td>-</td><td>-</td><td colspan="2">1</td><td>1</td></tr>
<tr><td rowspan="2">Evaluation Scheme</td><td colspan="3">ISE</td><td>ESE</td><td>IE</td><td>EE</td><td>Total</td></tr>
<tr><td colspan="3">--</td><td>--</td><td>50</td><td>--</td><td>50</td></tr>
<tr><td>Pre-requisites (if any)</td><td colspan="6">--</td></tr>
<tr><td>Course Rationale</td><td colspan="6">This course aims to develop ethical awareness and professional responsibility among engineering graduates. In a world of rapid technological change and complex socio-environmental challenges, engineers must balance technical excellence with moral integrity, social accountability, and human values. The course sensitizes students to ethical frameworks, professional codes of conduct, workplace dilemmas, and decision-making processes to help them act responsibly as global engineers and leaders.</td></tr>
<tr><td>Course Objectives</td><td colspan="6">1. To introduce the concepts of ethics, morals, and human values and their importance in engineering practice.
2. To develop awareness of professional responsibilities and ethical conduct expected from engineers.
3. To familiarize students with ethical theories and decision-making models for resolving professional dilemmas.
4. To promote ethical leadership, responsible communication, and sustainable practices in emerging technologies and workplace environments.</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">Upon completion of this course, student should be able to –
1. Explain the concepts of ethics, morals, and human values and their relevance to engineering practice.
2. Apply ethical principles and professional codes of conduct in workplace situations and engineering case studies.
3. Analyze ethical dilemmas using ethical theories and decision-making frameworks in engineering contexts.
4. Evaluate ethical issues related to emerging technologies, environmental responsibility, and professional leadership.</td></tr>
</table>

Course Outcome and Program Outcome Mapping

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO 1	1	1				2		3		2		2
CO 2	1	2				2		3	2	2		2
CO 3	2	3				2		3	2	2		2
CO 4	1	2	1			3	3	3	2	2	1	2

Level of Mapping as: Low 1, Moderate 2, High 3

Unit No.	Course Content	Hours
I	**Introduction to Ethics and Human Values** Definition, scope, and importance of ethics, Relationship between values, morals, and ethics, Human values and their role in engineering	2
II	**Professionalism and Engineering Ethics** Characteristics of a profession, Responsibilities of engineers toward society, employers, and peers, Role of professional bodies (e.g. IEEE, ASME, IEI)	2
III	**Ethical Theories and Decision-Making Models** Utilitarianism, duty ethics, virtue ethics, Ethical decision-making frameworks, Case studies in engineering contexts	3
IV	**Workplace Ethics and Professional Conduct** Conflict of interest, confidentiality, intellectual property rights, Ethics in research and publication, Harassment, discrimination, and whistleblowing	3
V	**Ethics in Emerging Technologies** Ethical issues in AI, automation, biotechnology, and data security, Environmental ethics and sustainable responsibility, Globalisation and cultural diversity in ethics	3
VI	**Ethical Leadership and Communication** Traits of ethical leaders, Team ethics and collaborative responsibility, Case presentations and role-play exercises	2
Reference Books		
1.	Charles E. Harris Jr., Michael S. Pritchard, Michael J. Rabins (2018). Engineering Ethics: Concepts and Cases. Cengage Learning, Boston.	
2.	Govindarajan, M., Natarajan, S., Senthil Kumar, V.S. (2004). Engineering Ethics. Prentice Hall of India, New Delhi.	
3.	Fleddermann, C.B. (2011). Engineering Ethics. Pearson Education, New Jersey.	
4.	Martin, M.W., Schinzinger, R. (2009). Introduction to Engineering Ethics. McGraw-Hill, New York.	
5.	R. Subramanian (2015). Professional Ethics. Oxford University Press, New Delhi.	

Year, Program, Semester	Multidisciplinary Minor I, 4th Semester onwards						
Course Code	MDM 1.5						
Course Category	Project Based Learning						
Course Title	**Mini Project**						
Teaching Scheme and Credits	**L**	**T**	**P**	**Total Contact Hours**		**Total Credits**	
	-	-	-	-		02	
Evaluation Scheme	**ISE**	**ESE**		**IOE**	**IPE**	**EOE**	**EPE**	**Total**
	00	00		50	-	50	-	100
Pre-requisites(if any)	Basics of unit processes and unit operations.						
Course Rationale	This course aims to provide students with practical exposure and hands-on experience in real-world industrial settings, fostering a deeper understanding of theoretical concepts through application. By engaging in this mini project, students will develop essential skills such as problem-solving, teamwork, and communication, preparing them for future challenges in the professional arena in green aspects of Industry.						
Course Objectives	The course teacher will 1. Facilitate application of theoretical knowledge. 2. Guide the students about enhancement of practical skills. 3. Explain about development of industry-relevant competencies.						
Course Outcomes	Upon completion of this course, student should be able to 1. Demonstrate application of theoretical concepts with instructor guidance. 2. Collaborate effectively in instructor-led team-based projects. 3. Communicate findings and insights professionally under instructor supervision.						

Course Outcome and Program Outcome Mapping

CO/PO	PO 1	PO 2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO1 2
CO 1	3	2			2				2			
CO 2			3						3		2	1
CO 3										3		2

Level of Mapping as: Low 1, Moderate 2, High 3

Course Content

Specialization Minor Program Based Mini Project is a dynamic course designed to bridge the gap between classroom learning and real-world application. All the students will engage themselves in a series of tasks and challenge that will enable them to apply theoretical concepts learned in previous courses to solve practical problems. The project work need to be carried out independently covering a range of topics relevant to their field of study, allowing them to explore different facets of the particular discipline and develop versatile skill sets pertaining to application of Green Technology.

This activity may be planned after 4th Semester and can be completed prior to 8th Semester of their Major studies.

Course Assessment Process
This particular evaluation will be the part of 8th Semester of the major structure. The course evaluation for the internals will be at the course teacher end while there will also be the external evaluation of the Project work. The teachers will follow the instructions as below: Evaluation Format: The evaluation may be conducted using a combination of assessment methods, including: • Rubric-based assessment for the project work and its report. • Peer evaluation for project. • Instructor-led discussions or presentations to evaluate communication skills and critical thinking. • Overall course grading based on a weighted average of individual assessments and participation. The evaluation format should be transparent, fair, and aligned with the course objectives and outcomes. Regular feedback and communication with students will ensure that the evaluation process remains supportive of their learning journey.