B.Tech. Degree

in

CIVIL ENGINEERING

CURRICULUM & SYLLABUS DETAILS

(For Students admitted in 2024 - 25 Onwards)

DEPARTMENT OF CIVIL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY

TIRUCHIRAPPALLI – 620015

TAMIL NADU, INDIA

VISION OF THE INSTITUTE

To be a university globally trusted for technical excellence where learning and research integrate to sustain society and industry.

MISSION OF THE INSTITUTE

To offer undergraduate, postgraduate, doctoral and modular programmes in multi-disciplinary / inter-disciplinary and emerging areas.
To create a converging learning environment to serve a dynamically evolving society.
To promote innovation for sustainable solutions by forging global collaborations with academia and industry in cutting-edge research.
To be an intellectual ecosystem where human capabilities can develop holistically.

VISION OF THE DEPARTMENT

Shaping infrastructure development with societal focus

MISSION OF THE DEPARTMENT

Achieve International Recognition by:
Developing Professional Civil Engineers
Offering Continuing Education
Interacting with Industry with emphasis on R&D

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

PEO1	Graduates of the Programme will contribute to the development of infrastructure that is sustainable.
PEO2	Graduates of the Programme, as part of an organization or as Entrepreneurs, will continue to learn to harness evolving technologies.
PEO3	Graduates of the Programme will be professional Civil Engineers with ethical and societal responsibility.

PROGRAMME OUTCOMES (POS)

PO1	Apply the knowledge of mathematics, science, engineering fundamentals, and Civil Engineering principles to the solution of complex problems in Civil Engineering.
PO2	Identify, formulate, research literature, and analyze complex Civil Engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.
PO3	Design solutions for intricate Civil Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, economic, and environmental considerations.
PO4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions related to Civil Engineering problems.
PO5	Create, select, and apply appropriate techniques, resources, and modern engineering tools such as CAD, FEM, and GIS including prediction and modelling to complex Civil Engineering activities with an understanding of the limitations.
PO6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional Civil Engineering practice.
PO7	Understand the impact of the professional Civil Engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for resilient infrastructural development.
PO8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Civil Engineering practice.
PO9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	Communicate effectively on complex Civil Engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage Civil Engineering projects and in multidisciplinary environments.
PO12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOS)

Graduates of the Civil Engineering Programme will have the

PSO1	Ability to implement resilient infrastructure development using sustainable technologies and materials.
PSO2	Capacity to work as part of multidisciplinary teams or as Entrepreneurs in applying modern tools which are constantly evolving.
PSO3	Integrity to be professional Civil Engineers with ethical and societal responsibility.

CURRICULUM FRAMEWORK AND CREDIT SYSTEM FOR THE FOUR-YEAR B.TECH. AND 3 YEAR B.SC. (ENGINEERING) PROGRAMME

COURSE STRUCTURE

Course Category	Courses	No. of Credits	Weightage (%)
GIR (General Institute Requirements)	23	56	34.7
PC (Programme Core)	15	52	33.1
Programme Elective (PE) / Open Elective (OE)	12	36	22.3
Essential Laboratory Requirements (ELR)	8 Maximum 2 per session up to 6th semester	16	9.9
Total	**58**	**160**	**100**
Minor (Optional)	Courses for 15 credits	15 Additional credits	-
Honors (Optional)	Courses for 15 credits	15 Additional credits	-

1. A minimum of seven Programme Core, each carrying 4 credits (II, III, IV, V, VI Semester).
2. Out of the 12 elective courses (PE / OE), students must complete at least eight Programme Electives (PE).
3. For a Minor Degree (MI), students must earn 15 credits in addition to the credit specified by the departments (160 credits), with the details of the Minor only mentioned on the transcript, not the degree certificate.
4. To qualify for an Honours Degree (HO), students must: (a) register for at least 12 theory courses and 2 ELRs in their second year, (b) consistently maintain a minimum CGPA of 8.5 during the first four sessions, (c) maintain a minimum CGPA of 8.5 in all sessions excluding honours courses, (d) successfully completed additional courses totalling 15 credits (3 numbers of 4 credit course and 1 number of 3 credit course), and (e) achieve at least a B grade in Honours courses, which must be distinct and at a higher level than PC and PE courses, preferably M. Tech. courses. Honours courses cannot be treated as programme electives and grades from these courses do not factor into CGPA calculations.
5. Project work is compulsory for B. Tech. programme. However, those students wish to carry out the intern outside the institute (8th semester) can opt for two electives courses equivalent to 6 credits. But the project work is compulsory for B. Tech. (Honours) degree

CURRICULUM FRAME WORK / FLEXIBLE CURRICULUM / NEP 2020 / NCrF / B.Tech.

Semester	GIR		PC		ELR		PE/OE		Total Credits	Credit Distribution
	No. of Courses	Credits	No. of Courses	Credits	No. of Courses	Credits	No. of Courses	Credits		
I	8	21	-	-	-	-	-	-	**21**	**40**
II	7	15	1	4	-	-	-	-	**19**	
III	-	-	4	14	2	4	2	6	**24**	**48**
IV	1	4	3	10	2	4	2	6	**24**	
V	1	3	4	14	2	4	1	3	**24**	**48**
VI	2	4	3	10	2	4	2	6	**24**	
VII	2	3	-	-	-	-	4	12	**15**	**24**
VIII	1	6	-	-	-	-	1	3	**9**	
Total	**22**	**56**	**15**	**52**	**8**	**16**	**12**	**36**	**160**	**160**

CURRICULUM FRAME WORK / FLEXIBLE CURRICULUM / NEP 2020 / NCrF / B.Sc. (Engineering)

	Sem	GIR		PC		ELR		PE/OE		Total Credits	Credit Distribution
		No. of Courses	Credits	No. of Courses	Credits	No. of Courses	Credits	No. of Courses	Credits		
Same as B.Tech.	**I**	8	21	-	-	-	-	-	-	**21**	**40**
	II	7	15	1	4	-	-	-	-	**19**	
	III	-	-	4	14	2	4	2	6	**24**	**48**
	IV	1	4	3	10	2	4	2	6	**24**	
B.Sc. Exit	**V**	1	3	2	8	2	4	2	6	**21**	**37**
	VI	4[@]	12	-	-	2	4	-	-	**16**	
After B.Sc. exit and join back for B. Tech.	**VII**	-	-	3	10	-	-	3	9	**19**	**35**
	VIII	1	1	2	6	-	-	3	9	**16**	
	Total	**22**	**56**	**15**	**52**	**8**	**16**	**12**	**36**	**160**	**160**

[@](Internship (2), Project Work (6), Industrial Economics course (3), and Industrial Lecture (1))

GENERAL INSTITUTE REQUIREMENTS (GIR) COURSES

Sl. No.	Course	Number of Courses	Max. Credits
1.	Mathematics	3	10
2.	Physics	1	3
	Physics Laboratory	1	2
3.	Chemistry	1	3
	Chemistry Laboratory	1	2
4.	Industrial Economics and Foreign Trade	1	3
5.	English for Communication	1	4
6.	Energy and Environmental Engineering	1	2
7.	Professional Ethics	1	3
8.	Engineering Graphics	1	3
9.	Engineering Practice	1	2
10.	Basic Engineering	2	4
11.	Introduction to computer Programming	1	3
12.	Branch Specific Course (Introduction to the Branch of study)	1	2
13.	Summer Internship	1	2
14.	Project work	1	6
15.	Comprehensive viva	1	1
16.	Industrial Lecture	1	1
17.	NSS/NCC/NSO	1	Pass / Fail
Total		**23**	**56**

CURRICULUM FRAMEWORK AND CREDIT SYSTEM / 160

SEMESTER I (JULY SESSION)

Sl. No.	Course Code	Course	Credits	Category
1.	HSIR11	English for Communication (Theory & Laboratory)	4	GIR
2.	MAIR11	Matrices and Calculus	3	GIR
3.	CHIR11	Chemistry	3	GIR
4.	CEIR15	Introduction to Civil Engineering	2	GIR
5.	EEIR11	Basics of Electrical and Electronics Engineering	2	GIR
6.	MEIR11	Basics of Mechanical Engineering	2	GIR
7.	MEIR12	Engineering Graphics	3	GIR
8.	CHIR12	Chemistry Laboratory	2	GIR
Total			**21**	

SEMESTER II (JANUARY SESSION)

Sl. No.	Course Code	Course	Credits	Category
1.	MAIR21	Complex Analysis and Differential Equations	3	GIR
2.	PHIR11	Physics	3	GIR
3.	CSIR12	Introduction to Computer Programming	3	GIR
4.	ENIR11	Energy and Environmental Engineering	2	GIR
5.	PRIR11	Engineering Practice	2	GIR
6.	PHIR12	Physics Laboratory	2	GIR
7.		NSS/NCC/NSO	0	GIR
8.	CEPC10	Engineering Mechanics (PC-I)	4	PC
Total			**19**	

SEMESTER III (JULY SESSION)

Sl. No.	Course Code	Course	Credits	Category
1.	CEPC11	Concrete Technology and Construction Management (PC-II)	4	PC
2.	CEPC12	Hydraulics and Fluid Machinery (PC-III)	4	PC
3.	CEPC13	Surveying (PC-IV)	3	PC
4.	CEPC14	Mechanics of Solids (PC-V)	3	PC
5.		Programme Elective – I	3	PE
6.		Programme Elective – II	3	PE
7.	CELR10	Building Planning and Drawing (ELR-I)	2	ELR
8.	CELR11	Survey Laboratory (ELR-II)	2	ELR
Total			**24**	

Note: Department(s) to offer Minor (MI) Course and Online Course (OC) to those willing students in addition to 24 credits.

SEMESTER IV (JANUARY SESSION)

Sl. No.	Course Code	Course	Credits	Category
1.	MAIR42	Probability and Numerical Techniques	4	GIR
2.	CEPC15	Analysis of Indeterminate Structures (PC-VI)	4	PC
3.	CEPC16	Soil Mechanics (PC-VII)	3	PC
4.	CEPC17	Water Supply Engineering (PC-VIII)	3	PC
5.		Programme Elective – III	3	PE
6.		Programme Elective – IV / Open Elective – I	3	PE/OE
7.	CELR12	Fluid Mechanics Laboratory (ELR-III)	2	ELR
8.	CELR13	Strength of materials and concrete Laboratory (ELR-IV)	2	ELR
Total			**24**	

SEMESTER V (JULY SESSION) / CONTINUING B.TECH.

Sl. No.	Course Code	Course	Credits	Category
1.	CEIR14	Professional Ethics	3	GIR
2.	CEPC18	Design of Reinforced Concrete Structural Elements (PC-IX)	4	PC
3.	CEPC19	Highway and Pavement Engineering (PC-X)	4	PC
4.	CEPC20	Foundation Engineering (PC-XI)	3	PC
5.	CEPC21	Environmental Pollution & Control Engineering (PC-XII)	3	PC
6.		Programme Elective – V / Open Elective – II	3	PE/OE
7.	CELR14	Geotechnical Engineering Laboratory (ELR-V)	2	ELR
8.	CELR15	Environmental Engineering Laboratory (ELR-VI)	2	ELR
Total			**24**	

SEMESTER V (JULY SESSION) / B.SC. (ENGINEERING) EXIT

Sl. No.	Course Code	Course	Credits	Category
1.	CEIR14	Professional Ethics	3	GIR
2.	CEPC18	Design of Reinforced Concrete Structural Elements (PC-IX)	4	PC
3.	CEPC19	Highway and Pavement Engineering (PC-X)	4	PC
4.		Programme Elective – V	3	PE
5.		Programme Elective - VI / Open Elective – II	3	PE/OE
6.	CELR14	Geotechnical Engineering Laboratory (ELR-V)	2	ELR
7.	CELR15	Environmental Engineering Laboratory (ELR-VI)	2	ELR
Total			**21**	

SEMESTER VI (JANUARY SESSION)

Sl. No.	Course Code	Course	Credits	Category
1.	CEIR19	Industrial Lecture	1	GIR
2.	HSIR13	Industrial Economics	3	GIR
3.	CEPC22	Irrigation Engineering and Hydraulic Structures (PC-XIII)	4	PC
4.	CEPC23	Railway, Airport and Harbour Engineering (PC-XIV)	3	PC
5.	CEPC24	Design of Steel Structural Elements (PC-XV)	3	PC
6.		Programme Elective – VI	3	PE
7.		Programme Elective – VII / Open Elective – III	3	PE/OE
8.	CELR16	Transportation Engineering Laboratory (ELR-VII)	2	ELR
9.	CELR17	Computational Laboratory (ELR-VIII)	2	ELR
Total			**24**	

SEMESTER VI (JANUARY SESSION) / B.SC. (ENGINEERING) EXIT

Sl. No.	Course Code	Course	Credits	Category
1.	CEIR17	Project Work	6	GIR
2.	CEIR16	Winter Internship	2	GIR
3.	CEIR19	Industrial Lecture	1	GIR
4.	HSIR13	Industrial Economics	3	GIR
5.	CELR16	Transportation Engineering Laboratory (ELR-VII)	2	ELR
6.	CELR17	Computational Laboratory (ELR-VIII)	2	ELR
Total			**16**	

SEMESTER VII (JULY SESSION)

Sl. No.	Course Code	Course	Credits	Category
1.	CEIR16	Summer Internship*	2	GIR
2.	CEIR18	Comprehensive Viva Voce	1	GIR
3.		Programme Elective – VIII	3	PE
4.		Programme Elective – IX	3	PE
5.		Programme Elective – X / Open Elective – IV	3	PE/OE
6.		Programme Elective – XI / Open Elective – V	3	PE/OE
Total			**15**	

*** Evaluation for Summer Internship**

SEMESTER VII (JULY SESSION) / REJOINS B.TECH. AFTER B.SC. (ENGINEERING) EXIT

Sl. No.	Course Code	Course	Credits	Category
1.	CEPC20	Foundation Engineering (PC-XI)	3	PC
2.	CEPC21	Environmental Pollution & Control Engineering (PC-XII)	3	PC
3.	CEPC22	Irrigation Engineering and Hydraulic Structures (PC-XIII)	4	PC
4.		Programme Elective – VII	3	PE
5.		Programme Elective – VIII	3	PE
6.		Programme Elective – IX / Open Elective – III	3	PE/OE
Total			**19**	

SEMESTER VIII (JANUARY SESSION)

Sl. No.	Course Code	Course	Credits	Category
1.		Programme Elective – XII / Open Elective – IV	3	PE/OE
2.	CEIR17	Project Work	**6**	GIR
Total			**9**	

SEMESTER VIII (JANUARY SESSION) / REJOINS B.TECH. AFTER B.SC. (ENGINEERING) EXIT

Sl. No.	Course Code	Course	Credits	Category
1.	CEIR18	Comprehensive Viva Voce	1	GIR
2.	CEPC23	Railway, Airport and Harbour Engineering (PC-XIV)	3	PC
3.	CEPC24	Basic Steel Structural Elements (PC-XV)	3	PC
4.		Programme Elective – X	3	PE
5.		Programme Elective – XI	3	PE
6.		Programme Elective – XII / Open Elective – IV	3	PE/OE
Total			**16**	

Semester	I	II	III	IV	V	VI	VII	VIII	Total
B.Tech.	19	21	24	24	24	24	15	9	**160**
B.Sc.	19	21	24	24	21	16	19	16	**160**

Note:

- **Curriculum should have 7 Programme Core courses shall be of 4 credits each.**
- **Out of 12 elective courses (PE/OE), the students should study at least eight programme elective courses (PE).**
- **Minor (MI): 15 credits over and above the minimum credit as specified by the departments (160). The details of MINOR will be mentioned in the transcript and in the Degree certificate.**
- **Honours (HO): 15 credits over and above the minimum credit as specified by the departments (160).**

ELECTIVES CHOICES

OPTION 1 / REGULAR B.TECH.

To get a B.Tech. degree in Civil Engineering, possible choices of electives in Programme Electives and Open Electives are,

Program Electives	Open Electives	Total
8	4	12
9	3	12
10	2	12
11	1	12
12	0	12

OPTION 2 / B.SC. (ENGINEERING) EXIT (AT END OF 3RD YEAR)

Program Electives	Open Electives	Total
3	2	5
4	1	5
5	0	5

OPTION 3 / B.TECH. WITH MINOR

To get a B.Tech. degree in Civil Engineering, and minor in other programmes, possible choices of electives in Programme Electives, Open Electives and Minor Electives are,

Program Electives	Open Electives	Minor Electives	Total
8	4	5	12 + 5
9	3	5	12 + 5
10	2	5	12 + 5
11	1	5	12 + 5
12	0	5	12 + 5

OPTION 4 / B.TECH. WITH HONOURS

To get a B.Tech. Honors degree in Civil Engineering, possible choices of electives in Programme Electives, Open Electives, and Honors electives are,

Program Electives	Open Electives	Honors Electives	Total
8	4	4	12 + 4
9	3	4	12 + 4
10	2	4	12 + 4
11	1	4	12 + 4
12	0	4	12 + 4

OPTION 5 / B.TECH. WITH HONOURS AND MINOR

To get a B.Tech. Honors degree in Civil Engineering, and minor in other programmes possible choices of electives in Programme Electives, Open Electives, and Honors electives are,

Program Electives	Open Electives	Honors Electives	Minor Electives	Total
8	4	4	5	12 + 4 + 5
9	3	4	5	12 + 4 + 5
10	2	4	5	12 + 4 + 5
11	1	4	5	12 + 4 + 5
12	0	4	5	12 + 4 + 5

Note: No Minor or Honours will be awarded for B.Sc. But student can credit minors and honours during the 6 semesters, and redeem it to obtain a minor or honours after rejoining and completing B.Tech. Also, B.Sc. students shall only do programme electives in place of their project work in 6th semester.

LIST OF COURSES

PROGRAMME CORE (PC)

Sl. No.	Course Code	Course Title	Prerequisites	Credits
1.	CEPC10	Engineering Mechanics	-	4
2.	CEPC11	Concrete Technology and Construction Management	-	4
3.	CEPC12	Hydraulics and Fluid Machinery	-	4
4.	CEPC13	Surveying	-	3
5.	CEPC14	Mechanics of Solids	CEPC10	3
6.	CEPC15	Analysis of Indeterminate Structures	CEPC14	4
7.	CEPC16	Soil Mechanics	-	3
8.	CEPC17	Water Supply Engineering	-	3
9.	CEPC18	Design of Reinforced Concrete Structural Elements	CEPC15	4
10.	CEPC19	Highway and Pavement Engineering	-	4
11.	CEPC20	Foundation Engineering	CEPC16	3
12.	CEPC21	Environmental Pollution & Control Engineering	-	3
13.	CEPC22	Irrigation Engineering and Hydraulic Structures	CEPC12	4
14.	CEPC23	Railway, Airport and Harbour Engineering	-	3
15.	CEPC24	Design of Steel Structural Elements	CEPC15	3

PROGRAMME ELECTIVES

Stream I (Construction Technology and Management)

Sl. No.	Course Code	Course Title	Prerequisites	Credits
1.	CEPE10	Construction Techniques and Equipment	-	3
2.	CEPE11	Construction Management	-	3
3.	CEPE12	Project Planning, Scheduling and Control	-	3
4.	CEPE13	Quality and Safety Management in Construction Projects	-	3
5.	CEPE14	Estimation and Costing in Civil Engineering	-	3
6.	CEPE15	Lean Concepts and Tools in Construction Projects	-	3
7.	CEPE16	Project Risk Management	-	3
8.	CEPE17	Project and Business Strategy Management in Construction	-	3
9.	CEPE18	Infrastructure Project Delivery and Management	-	3
10.	CEPE19	Sustainable Practices in Construction	-	3

Stream II (Environmental Engineering)

Sl. No.	Course Code	Course Title	Prerequisites	Credits
1.	CEPE20	Air Pollution Management	CEPC17	3
2.	CEPE21	Industrial Wastewater Treatment	CEPC17	3
3.	CEPE22	Environmental Management and Impact Assessment	CEPC17	3
4.	CEPE23	Solid Waste Management Techniques	CEPC17	3
5.	CEPE24	Models for Air and Water Quality	CEPC17	3
6.	CEPE25	Hazardous Waste Management	CEPC17	3
7.	CEPE26	Indoor Air Quality	CEPC17	3
8.	CEPE27	Health Safety and Environment	CEPC17	3

Stream III (Geotechnical Engineering)

Sl. No.	Course Code	Course Title	Prerequisites	Credits
1.	CEPE30	Advanced Foundation Engineering	CEPC20	3
2.	CEPE31	Geotechnical Earthquake Engineering	CEPC20	3
3.	CEPE32	Reinforced Earth and Geotextiles	CEPC20	3
4.	CEPE33	Earth and Earth Retaining Structures	CEPC20	3
5.	CEPE34	Marine Foundation Engineering	CEPC20	3
6.	CEPE35	Ground Improvement Techniques	CEPC20	3
7.	CEPE36	Rock Mechanics	-	3
8.	CEPE37	Geoenvironmental Engineering	CEPC20	3
9.	CEPE38	Fundamentals of Geosynthetic Engineering	-	3
10.	CEPE39	Engineering Geology	-	3

Stream IV (Geospatial Techniques)

Sl. No.	Course Code	Course Title	Prerequisites	Credits
1.	CEPE40	Geodetic Surveying	CEPC13	3
2.	CEPE41	Advanced Surveying Techniques	CEPC13	3
3.	CEPE42	Geodesy	CEPC13	3
4.	CEPE43	Disaster Modelling and Management	CEPC13	3
5.	CEPE44	AI/ML & DL for Remote Sensing and GIS	CEPC13	3
6.	CEPE45	Geomatics in Water Resources Engineering	CEPC13	3
7.	CEPE46	Advanced Geospatial Techniques	CEPC13	3
8.	CEPE47	Thermal and Hyperspectral Remote Sensing	CEPC13	3

Stream V (Transportation Engineering)

Sl.No.	Course Code	Course Title	Prerequisites	Credits
1.	CEPE50	Traffic Engineering and Safety	CEPC19	3
2.	CEPE51	Pavement Analysis and Design	CEPC19	3
3.	CEPE52	Transportation Planning	-	3
4.	CEPE53	Urban Transportation Systems	-	3
5.	CEPE54	Intelligent Transportation Systems	-	3
6.	CEPE55	Pavement Management System	CEPC19	3
7.	CEPE56	Pavement Material Characterisation	-	3
8.	CEPE57	Sustainable Transportation	-	3

Stream VI (Structural Engineering)

Sl.No.	Course Code	Course Title	Prerequisites	Credits
1.	CEPE60	Elementary Structural Dynamics	CEPC10	3
2.	CEPE61	Maintenance and Rehabilitation of Structures	CEPC11	3
3.	CEPE62	Conceptual Design of Structures	CEPC10	3
4.	CEPE63	Prestressed Concrete Structures	CEPC18	3
5.	CEPE64	Advanced Reinforced Concrete Design	CEPC18	3
6.	CEPE65	Advanced Steel Structural Elements	CEPC24	3
7.	CEPE66	Advanced Structural Analysis	CEPC15	3
8.	CEPE67	Design of Offshore and Coastal Structures	CEPC18 CEPC24	3
9.	CEPE68	Prefabricated Structures	CEPC18 CEPC24	3
10.	CEPE69	Heritage Structures	CEPC14	3
11.	CEPE70	Earthquake Resistant Structures	CEPC18 CEPC24	3
12.	CEPE71	Steel Concrete Composite Structures	CEPC18 CEPC24	3
13.	CEPE72	Metallurgy for Civil Engineers	CEPC24	3
14.	CEPE73	Basic Bridge Engineering	CEPC18 CEPC24	3
15.	CEPE74	Advanced Mechanics of Solids	CEPC10 CEPC11	3
16.	CEPE75	Optimisation Techniques in Civil Engineering	-	3
17.	CEPE76	Introduction to Finite Element Methods	CEPC10 CEPC15	3
18.	CEPE77	Structural Health Monitoring	CELR13	3
19.	CEPE78	Introduction to Matrix Method of Structural Analysis	CEPC15	3

Stream VII (Water Resources Engineering)

Sl. No.	Course Code	Course Title	Prerequisites	Credits
1.	CEPE80	Groundwater Hydrology	CEPC12	3
2.	CEPE81	Applied Hydraulics Engineering	CEPC12	3
3.	CEPE82	Simulation Modelling for Water Resources Engineering	CEPC12	3
4.	CEPE83	Coastal Engineering	CEPC12	3
5.	CEPE84	Surface water hydrology	CEPC12	3
6.	CEPE85	AI /ML for water Resources Engineering	CEPC12	3
7.	CEPE86	Hydroclimatology	CEPC12	3
8.	CEPE87	River Engineering	CEPC12	3
9.	CEPE88	Watershed Management	CEPC12	3
10.	CEPE89	Water Resources Systems Planning	CEPC12	3

OPEN ELECTIVE (OE)

The courses listed below are offered by the Department of Civil Engineering for students of all Departments.

Sl. No.	Course Code	Course Title	Prerequisites	Credits
1.	CEOE10	Remote Sensing and GIS	-	3
2.	CEOE11	Ocean Energy	-	3
3.	CEOE12	Urban and Regional Planning	-	3
4.	CEOE13	Experimental Stress Analysis	-	3
5.	CEOE14	Sustainable Infrastructure	-	3
6.	CEOE15	Disaster Modelling and Management	-	3
7.	CEOE16	Standardization and Conformity Assessment	-	3
8.	CEOE17	Computational Fluid dynamics	-	3
9.	CEOE18	Hydroinformatics	-	3
10.	CEOE19	Reliability methods	-	3
11.	CEOE20	Uncertainty Modelling, Analysis and Quantification	-	3
12.	CEOE21	Application of Remote Sensing and GIS in Agriculture and Forestry	-	3

MINOR (MI) (OFFERED FOR THE STUDENTS OF OTHER DEPARTMENTS)

Students of other departments who desire B.Tech. Minor in Civil Engineering can opt to study any 5 of the courses listed below.

Sl. No.	Course Code	Course Title	Prerequisites	Credits
1.	CEMI10	Construction Technology	-	3
2.	CEMI11	Surveying Practices	-	3
3.	CEMI12	Structural Analysis and Design	-	3
4.	CEMI13	Soils and Foundations	-	3
5.	CEMI14	Transportation Systems	-	3
6.	CEMI15	Water and Air Pollution Management	-	3
7.	CEMI16	Irrigation Engineering and Management	-	3
8.	CEMI17	Quantity Estimation and Valuation	-	3

ESSENTIAL PROGRAMME LABORATORY REQUIREMENT (ELR)

Sl. No.	Course Code	Course Title	Prerequisites	Credits
1.	CELR10	Building Planning & Drawing	-	2
2.	CELR11	Survey Laboratory	-	2
3.	CELR12	Fluid Mechanics Laboratory	-	2
4.	CELR13	Strength of Materials and Concrete Laboratory	-	2
5.	CELR14	Geotechnical Engineering Laboratory	-	2
6.	CELR15	Environmental Engineering Laboratory	-	2
7.	CELR16	Transportation Engineering Laboratory	-	2
8.	CELR17	Computational Laboratory	-	2

ONLINE COURSES (OC)

Note: Course list shall be updated regularly at the start of each Academic Year or Semester by the department NPTEL Coordinator. The students shall be able to select an online course from then available list.

ADVANCED LEVEL COURSES FOR B.TECH. (HONOURS)

Sl. No.	Course Code	Course Title	Prerequisites	Credits
1.	CEHO10	Dynamics of Structures	CEPC10 CEPE66	4
2.	CEHO11	Finite Element Analysis	CEPE66	4
3.	CEHO12	Theory of Elasticity and Introduction to Plasticity	CEPC10	4
4.	CEHO13	Nonlinear Analysis of Structures	CEPC15	3
5.	CEHO14	Theory of Traffic Flow	CEPC19	3
6.	CEHO15	Pavement Construction and Management	CEPC19	4
7.	CEHO16	Dynamics of Soils and Foundations	CEPC20	4
8.	CEHO17	Soil Exploration and Field Testing	CEPC20	3
9.	CEHO18	Physicochemical Methods for Water and Wastewater Treatment	CEPC21	4
10.	CEHO19	Biological Treatment of Wastewater	CEPC21	4
11.	CEHO20	Free Surface Flow	CEPC12	3
12.	CEHO21	Wave Hydrodynamics	CEPC12	3
13.	CEHO22	Advanced Remote Sensing Techniques	CEPC13	4
14.	CEHO23	River Hydraulics and Sediment Transport	CEPC22	4
15.	CEHO24	Advanced Soil Mechanics	CEPE16	3
16.	CEHO25	Soft Computing Techniques in Civil Engineering	-	3
17.	CEHO26	Quantitative Methods in Construction Management	-	3

MICROCREDITS (MC)

(Students can opt 3 courses of 1 credit (4 weeks) each as microcredits instead of 1 OE/OC)

Note: Course list shall be updated regularly at the start of each Academic Year or Semester by the department NPTEL Coordinator. The students shall be able to select an online course from then available list.

COURSE OUTCOME AND PROGRAMME OUTCOME MAPPING

PROGRAMME CORE (PC)

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

3 - High; 2 - Medium; 1 - Low

Course code	Course Title	COs	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CEPC10	Engineering Mechanics	CO1	Can estimate the system of forces, free-body diagrams, law of mechanics, Lami's theorem	3	3	3		1	1					1	3	2	2	1
		CO2	Will be able to arrive sectional properties such as centroid, centre of gravity, area moment of Inertia, mass moment of inertia	3	3	3		1	1					1	3	2	2	1
		CO3	Will be able to estimate the Frictional forces, laws of friction at different planes	3	3	3		1	1					1	3	2	2	1
		CO4	Able to analyse simple stresses, strains and elastic constants	3	3	3		2	1					1	3	2	2	1
		CO5	Better understanding of trusses by method of joints, principles of dynamics, vibration of simple systems	3	3	3		2	1					1	3	2	2	1
CEPC11	Concrete Technology and Construction Management	CO1	Assess and test the fresh, mechanical, and durability properties of concrete using standard and non-destructive methods.	3	3	2	2	2	1	2	1	1	1	1	1	2	1	1
		CO2	Develop and optimize concrete mix designs to meet specific performance criteria and quality standards.	3	3	3	2	3	2	2	1	2	1	2	1	3	2	1
		CO3	Perform the role of a construction/project manager efficiently with precise	3	2	2	3	1	3	3	3	3	3	1	1	3	3	3

Course code	Course Title	COs	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
			knowledge of the roles and responsibilities															
		CO4	Analyse and estimate the resources required for a construction project	1	2	2	2	2	1	2			2	1	1	2	2	2
		CO5	Comprehend and apply project planning and scheduling tools to estimate the time and cost of a construction project	2	2	2	2	3	1	2		1	2	1		2	2	2
CEPC12	Hydraulics and Fluid Machinery	CO1	Understands the basic principles of fluid mechanics.	3	3	2		1		1		1		1	1	2	1	-
		CO2	Understands the concepts of statics and dynamics of fluid flow.	3	3	2		1		1		1		1	1	2	1	-
		CO3	Develops skills in analyzing fluid flows through the proper use of modeling and the application of the basic fluid-flow principles.	3	2	1		2		1		1		1	1	2	2	-
		CO4	Acquire knowledge in the selection of type of turbine required with reference to available head of water and also used for Identification of type of turbine with estimated specific speed.	3	2	3		1		2		1		1	1	2	1	-
		CO5	Capable of estimating efficiency of different pumps and performance of the pumps with the study of characteristics curves.	3	2	3		1		1		1		1	1	2	1	-
CEPC13	Surveying	CO1	Knowledge of the importance of preliminary surveying such as chain surveying, compass surveying and error adjustment in the field of civil engineering applications such as structural, high way engineering, geotechnical engineering	3	3		1					2	2	2	1	1	3	2
		CO2	Ability to plan a survey, taking accurate measurements, field booking, plotting	3	3		1					2	2	2	1	1	3	2

Course code	Course Title	COs	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
			and adjustment of traverse can be understood through leveling, plane table surveying etc															
		CO3	Understanding of fundamental function, use of Theodolite and tacheometry in practical applications such as road alignment, height of building, control point setting etc, g with respect to utility and precision through the use of Theodolite, tacheometry	3	3		1					2	2	2	1	1	3	2
		CO4	Ability to understand the concepts of Trigonometrical Levelling, Triangulation in surveying	3	3		1					2	2	2	1	1	3	2
		CO5	Understanding the importance of advanced surveying measurement techniques in civil engineering applications.	3	3		1	3				2	2	2	1	1	3	2
CEPC14	Mechanics of Solids	CO1	Determine the strength parameters of the materials and solve principal stress and principal plane problem	3	3	1	2	1	1	1	1	1	1	1	1	2	1	1
		CO2	Determine shear force, bending moment, bending and shear stress distribution	3	3	1	2	1	1	1	1	1	1	1	1	2	1	1
		CO3	Determine deflection of a beam for various loading conditions and also trusses	3	3	1	2	1	1	1	1	1	1	1	1	2	1	1
		CO4	Analyze members subjected to torsion	3	3	1	2	1	1	1	1	1	1	1	1	2	1	1
		CO5	Visualize the behavior of column for combined bending and axial loading	3	3	1	2	1	1	1	1	1	1	1	1	2	1	1
CEPC15	Analysis of Indeterminate Structures	CO1	Analyse the basic indeterminate beams such as Propped cantilevers, Continuous and Fixed Beams	3	3	1	1	1	1	1	1	2	2	2	3	2	2	2
		CO2	Use various classical methods for	3	3	1	2	1	1	1	1	1	2	2	3	2	2	2

Course code	Course Title	COs	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
			analysis of indeterminate structures															
		CO3	Determine the effect of support settlements for indeterminate structures	3	3	2	2	1	1	1	1	1	2	2	3	2	2	2
		CO4	Apply the concepts of ILD and moving loads on determinate structures	3	3	1	1	1	1	1	1	1	2	2	3	2	2	2
		CO5	Apply approximate methods to analyse multistorey plane frames	3	3	1	2	1	1	1	1	2	2	2	3	2	2	2
CEPC16	Soil Mechanics	CO1	Understand the importance of geotechnical engineering in civil engineering and do proper soil classification and the phase system to solve problems	3	2	1	2		2	1	2	2	2	1	2	2	2	2
		CO2	Solve any practice problems related to soil stresses estimation, permeability, seepage including flow net diagram.	3	3	2	2	3	2	1	2	1	3		2	2	2	3
		CO3	Do proper stress estimation under any system of foundation loads	2	3	3	3	2	2	1	2		2		2	3	1	2
		CO4	Estimate appropriate soil strength parameters with respect to the drainage conditions	3	3	2	3	2	2	2	2		3		2	3	1	3
		CO5	Solve any practical problems related to consolidation like consolidation settlement, time rate of settlement	2	3	3	3	2	2	1	2		3		2	3	1	3
CEPC17	Water Supply Engineering	CO1	estimate various water quality parameters	3	3	3	3	3		3	3					3	1	2
		CO2	forecast the population and estimate the water demand	3	3		3		3		3	1	3			2	1	3
		CO3	differentiate various intake structures and select suitable pipe material for water conveyance	2	2		2		2			3	2	3		1	2	2
		CO4	design various water treatment units	2	3				2		2	2	3			1	1	3

Course code	Course Title	COs	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
		CO5	analyse water distribution networks		1		3	2		2	2			1	2	2	2	1
CEPC18	Design of Reinforced Concrete Structural Elements	CO1	Apply the fundamental concepts of working stress method and limit state method	3	3	2	3	1			1	2	2	2	2	3	3	2
		CO2	Use IS code of practice for the design of concrete elements	3	3	2	3	1			1	2	2	2	2	3	3	2
		CO3	Design the beams, slab, stairs, column and footing	3	3	2	3	1			1	2	2	2	2	3	3	2
		CO4	Draw various RCC structural elements	3	3	2	3	1			1	2	2	2	2	3	3	2
		CO5	Detail various RCC structural elements	3	3	2	3	1			1	2	2	2	2	3	3	2
CEPC19	Highway and Pavement Engineering	CO1	Carry out surveys involved in planning and highway alignment	3	1	1	1								3	1	1	-
		CO2	Design cross section elements, sight distance, horizontal and vertical alignment	3	3	2	3	2		2	2	1	2	1	1	3	2	2
		CO3	Implement traffic studies, traffic regulations and control, and intersection design	3	3	3	2		1			3	2	3	1	2	2	1
		CO4	Determine the characteristics of pavement materials and design of pavements	3	3	3	3	3	1	2	2	1	2	1	1	3	2	2
		CO5	Understand construction and maintenance of pavements	3	1	2	1		2	3	1	1	1	1	2	3	1	2
CEPC20	Foundation Engineering	CO1	Understand the importance of soil investigation for any civil engineering construction	2	2	2	3	3	2	2	2	3	2	2	2	3	3	2
		CO2	To analyse earth retaining structures in various types of soil medium	3	3	3	2	2	2	1	2	2	1	2	2	3	2	2
		CO3	Do proper bearing capacity estimation including IS code methods	3	3	3	3	2	2	2	3	1	2	2	2	3	2	3
		CO4	Do proper foundation proportioning for	3	3	3	2	2	2	2	2	1	2	2	3	3	2	2

Course code	Course Title	COs	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
			any kind of shallow foundation system and also get exposed in foundation settlement analysis															
		CO5	To estimate pile and pile group capacity for any kind of soils including group efficiency and negative friction	3	3	3	2	2	2	2	2	1	2	2	2	3	2	2
CEPC21	Environmental Pollution & Control Engineering	CO1	determine the characteristics of sewage	2					3	2		2	3		3	1	2	2
		CO2	design treatment units for wastewater	3	3	3	3	2		2			2		2	3	1	1
		CO3	predict the quality of water in river using mathematical models	3	3	2	2		2			3				2	1	1
		CO4	select suitable treatment units for specific industries	3	2	1	2					1	2	2		2	1	1
		CO5	suggest suitable control measures for air pollution and solid waste management		2	3	2	1	1	1		2	2	2		2	2	1
CEPC22	Irrigation Engineering and Hydraulic Structures	CO1	Ability to explain the necessity, development, and types of irrigation systems, along with national and regional water policies.	3	2	1	2	2	2	3	3	3	2	3	2	3	3	1
		CO2	Proficiency in analysing soil properties, water retention, and soil moisture measurement techniques.	3	3	1	3	3	3	2	2	3	1	3	1	2	2	2
		CO3	Competence in calculating crop water demand, consumptive use, and irrigation requirements using tools	3		2	2	2	3	3			3	3	3		3	3
		CO4	Skills to design and evaluate diversion headworks, dams, spillways, and other impounding structures based on various theories and principles	3	2	3	1	2	3	3	3	2	2	3	2	3	3	2
		CO5	Ability to design, align, and maintain canal irrigation systems, and apply modern irrigation methods like micro-	3	3	3	2		2	3	3	2	2	3	3		2	3

Course code	Course Title	COs	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
			irrigation, and use artificial intelligence for irrigation scheduling															
CEPC23	Railway, Airport and Harbour Engineering	CO1	Carry out the surveys for railways, airports and harbours.	3	3		3		3		1			3		3	3	
		CO2	Perform geometric design for the three modes.	3	3		3	1	1		1	1		2		3	3	
		CO3	Plan the layout of different types of terminals.	3	3		3	1	2		1				1	3	3	
		CO4	Apply the principles of bus transit, MRTS and LRT.	3		2	3		1	1	1	1	2		1	3		2
		CO5	Demonstrate the fundamentals of Intelligent Transportation Systems.	3		2		2	1		1	1	2	2		3		2
CEPC24	Basic Steel Structural Elements	CO1	Apply the IS code of practice for the design of steel structural elements.	3	3	3	2	1						1	1	2	1	-
		CO2	Design compression using simple and built-up sections.	3	3	3	2	1						1	1	2	1	-
		CO3	Understand the behavior of flexural members and design the laterally restrained and unrestrained beams.	3	3	3	2	1						1	1	2	1	-
		CO4	Analyze the behavior of bolted connections and design them.	3	3	3	2	1						1	1	2	1	-
		CO5	Design welded connections for both axial and eccentric forces.	3	3	3	2	1						1	1	2	1	-

3 - High; 2 - Medium; 1 - Low

PROGRAMME ELECTIVES (PE)

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

Stream I: Construction Technology and Management

3 - High; 2 - Medium; 1 - Low

Course code	Course Title	CO	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O 2	PS O 3
CEPE10	Construction Techniques and Equipment	CO1	Understand the principles of construction of building components.	1			1	2		3	3	2	2	3		1	3	1
		CO2	Assess the use of various construction techniques and their application in real-world projects.	1	1		3	3		2			2	3		3	1	
		CO3	Assess the application of prefabricated construction and building services in real-world projects.	1	1		3	3		1			2	3		3	1	
		CO4	Comprehend the use of different construction equipment and analyse the planning and operation of various equipment in project sites.	1	3		3	2	1				3			2		
		CO5	Comprehend and assess the application of Industry 4.0 technologies in construction.	1	1		3	3		1			3	2		3	1	
CEPE11	Construction Management	CO1	To learn and estimate time and cost with regard to manpower, materials and equipment of a construction projects				3	1	1	2	3	3	1			2	1	3
		CO2	To learn and apply concepts related to project planning and scheduling	1	2		2	2										1
		CO3	To learn the types of construction contracts and their drafting	2	3		2	3	1									1
		CO4	To learn the application of software in construction management				2	2	3				3	2		1	1	1

		CO5	To learn and estimate time and cost with regard to manpower, materials and equipment of a construction projects	1	2		2	3					2	1	1	1		
CEPE12	Project Planning, Scheduling and Control	CO1	Understand the fundamental project management concepts and principles	1	1				2			1		3	1		3	1
		CO2	Comprehend the principles and processes related to project scope management	1	1				2					3	1		2	1
		CO3	Gain the ability to apply concepts and tools related to project scheduling in real-world projects	2	1				1	2				3	2		3	1
		CO4	Comprehend the use of advanced project scheduling tools	2	1				2					3	3		2	1
		CO5	Assess the use of advanced technology platforms in project scheduling and control	2	1				2					3	3		1	1
CEPE13	Quality and Safety Management in Construction Projects	CO1	comprehend the significance and nuances of quality management in construction			1			2		1			3	1			1
		CO2	perform the role of quality engineers/managers and gain the ability to apply quality principles and tools in project-based scenarios	1		2			2		1	2		3	1			1
		CO3	comprehend standards and regulations related to construction quality management that need to be followed at workplace			1			2		1	2		3	1			1
		CO4	perform the role of safety engineers/managers and gain the ability to apply safety principles and tools in project-based scenarios			2			2		1			3	1			1
		CO5	comprehend standards and regulations related to construction safety management that need to be followed at workplace						3		1			2	1			2

CEPE14	Estimation and Costing in Civil Engineering	CO1	Understand and learn the basic concepts related to estimating and costing in construction	2	1		1				2	2		3			1	1
		CO2	Apply and gain the ability to estimate the quantities of items of works involved in buildings, water supply and sanitary works, road works and irrigation works	3	3		3				2	1	2	2			2	1
		CO3	Apply and gain the ability to estimate key project resources such as labour, material, and plant and machinery (LMP) and carry out rate analysis	3	3		3				2	3	2	2			2	1
		CO4	Comprehend and apply concepts related to the valuation of buildings and structures	3	3		3				2		2	2			2	1
		CO5	Able to write reports on the estimation of key construction structures				3				2		3	3			2	1
CEPE15	Lean Concepts and Tools in Construction Projects	CO1	Understand the relevance of lean thinking and its application in construction context			1			1	3	2		3	3		3	1	2
		CO2	Assess the different types of waste generated in construction and how it can be managed			3			3	3	2	2	3	3		3	1	3
		CO3	Analyse the various factors affecting construction productivity and means for improving productivity in project sites			3			3	3	2	3	3	3		3	2	3
		CO4	Apply and gain the ability to realise the benefits of lean tools application in project sites			2			2	3	2		3	3		3	2	3
		CO5	Comprehend and analyse the challenges in implementation of lean construction			2			2	2	2	2	3	3		3	2	2
CEPE16	Project Risk Management	CO1	Understand and assess the significance of uncertainties and risks in the context of construction projects and businesses	1	2	1				1	1	1	1			1	2	1

		CO2	Learn and apply the various risk management frameworks in the context of construction projects	1	1	2	1	1					1	1		1	1	2
		CO3	Learn and gain the ability to apply the various risk identification and risk analysis tools in the context of construction projects		2	1	2	3						1	1		2	1
		CO4	Assess and implement the various risk management strategies in projects	1	2	2	1	1	1			1	1	2		1	3	2
		CO5	Comprehend and gain the ability to examine the role of key stakeholders in the context of construction project risk management		1	1			2	1	1	2	3	2			1	1
CEPE17	Project and Business Strategy Management in Construction	CO1	Understand the concepts related to strategy management in construction projects and businesses	1	2					1						1	1	
		CO2	Comprehend the role of management in strategy formation and management	1		3			1					1			1	
		CO3	Learn and gain the ability to apply strategy management frameworks and models in the context of construction projects and organizations			3		1					1			1	1	
		CO4	Analyse the implementation outcomes of different types of strategies in construction projects and organisations		2		1							1			1	
		CO5	Gain the ability to assess the implementation of strategies and their performance in projects and organisations				1				1				1	1	1	
CEPE18	Infrastructure Project Delivery and Management	CO1	Understand how infrastructure projects are conceptualized and planned and the various project lifecycle phases			1	2		2	1			3	1	3	1	1	1
		CO2	Comprehend and apply concepts related to the feasibility of infrastructure projects, infrastructure economics and finance				1		2			1	3		2		2	

		CO3	Assess and gain the ability to identify various risks and apply management strategies to address them				2		2			1	2		1		1	
		CO4	Comprehend and examine the role of various internal and external stakeholders and their management strategies in the context of infrastructure projects						1			2	1				1	1
		CO5	Assess the application of new technological advancements and new contract management models in the context of infrastructure projects						2			1	1	1	2	1	2	2
CEPE19	Sustainable Practices in Construction	CO1	Understand the importance of sustainable construction practices in the context of present and future economies	1			1		2	3				1	2	3	2	2
		CO2	Learn and assess the various types of energy use in buildings		1		1		2				1		2		1	
		CO3	Apply and gain the ability to utilise life cycle assessment (LCA) techniques in the context of building construction						1	2				1	3		1	
		CO4	Comprehend the use of various green rating standards in building construction		1				2	2			1		2		1	
		CO5	Comprehend the aspects of social sustainability in the construction industry						1	3				1	2	3		1

3 - High; 2 - Medium; 1 - Low

Stream II: Environmental Engineering

3 - High; 2 - Medium; 1 - Low

Course code	Course Title	CO	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CEPE20	Air Pollution Management	CO1	Identify the types and sources of air pollutants	1	3	3		3						1	1	2	2	
		CO2	Predict the effects of air pollutants on human health and the environment	3	3	3	3	3	3	3	3		3	2	1	3	2	3
		CO3	Choose appropriate technologies for removal of air pollutants	3	3	3	3	3						1		3	1	
		CO4	Measure the pollutant concentration in indoor environment	2	2		3	1								2	1	
		CO5	Suggest the control techniques for indoor air pollution	2	3	3	3	3	2	2			2			3	1	2
CEPE21	Industrial Wastewater Treatment	CO1	Recognize various environmental impacts due to improper management of industrial wastewater	3	3		3	2	3	1					2	2	1	2
		CO2	Propose strategies for the prevention and control of industrial pollution	3	3	3	3	3								3	1	-
		CO3	Determine appropriate technologies for the treatment of industrial wastewater	2	2	2	2	2	3	3	2					3	1	2
		CO4	Suggest safe sludge disposal techniques to minimize environmental risks	2	3	3	3	3	2	2			2			3	1	2
		CO5	Recommend the implementation of zero effluent discharge systems in industries	3	3		3	2	3	1					2	2	1	2
CEPE22	Environmental Management and Impact Assessment	CO1	Analyse the environmental impacts of proposed projects		2		1		2	3			1		2	2	1	1
		CO2	Categorize the type of EIA required as per the EIA notification	2	3		3	3		3			1			3	1	1
		CO3	Predict and assess the impact on the environment	3	2		2	1		2			1		1	2	1	1

		CO4	Propose mitigation measures to avoid environmental impacts	2					3	3	1		2	1		2	1	2
		CO5	Prepare the EIA report with environmental management plan	1	1	1	2	1		2		2	3	3	2	1	2	1
CEPE23	Solid Waste Management Techniques	CO1	Quantify and categorize solid wastes for any region	2	2		3	3								2	1	-
		CO2	Understand the various functional elements in solid waste management	3	3	3	3	3	3	3	3	2	1	3	1	3	3	3
		CO3	Analyse the collection route and collection system	3	3	3	2	3						2		2	2	-
		CO4	Select suitable waste processing technologies	2	3	3	3	3	2	2	2		2			3	1	2
		CO5	Design a suitable sanitary landfill for disposal of solid waste	3	3		3	3								2	1	-
CEPE24	Models for Air and Water Quality	CO1	Apply mass balance concept for air and water quality prediction	3	3	3	3	3								3	1	-
		CO2	Develop mathematical models for water quality based on transport mechanisms	3	3	3	3	3								3	1	-
		CO3	Predict the quality of water in river and estuaries using specific models	3	3		3	3								2	1	-
		CO4	Evaluate eutrophication potential of lakes and bacterial growth kinetics	3	3		3	3								2	1	-
		CO5	Estimate the air pollutant concentration using dispersion models	1	3	3		3						1	1	2	2	-
CEPE25	Hazardous Waste Management	CO1	Identify and manage different types of hazardous wastes	2	2		3	3								2	1	-
		CO2	Select suitable waste minimization and resource recovery techniques for hazardous waste management	3	3	3	3	3	3	3	3	2	1	3	1	3	3	3
		CO3	Understand the environmental regulations and policies related to hazardous waste management	3	3	3	2	3						2		2	2	-

		CO4	Provide awareness for promoting sustainable e- waste management practices in local communities	2	3	3	3	3	2	2	2		2			3	1	2
		CO5	Suggest suitable disposal method for biomedical waste	3	3		3	3								2	1	-
CEPE26	Indoor Environmental Quality	CO1	Identify and analyse the sources and types of indoor air pollutants and assess their impacts on indoor air quality	1	3	3		3						1	1	2	2	-
		CO2	Measure the indoor air pollution using relevant instrumentation	3	3	3	3	3	3	3	3		3	2	1	3	2	3
		CO3	Apply simple mass balance models to predict pollutant concentrations in indoor environments	3	3	3	3	3						1		3	1	-
		CO4	Evaluate the human exposure to indoor air pollutants using mathematical models	2	2		3	1								2	1	-
		CO5	Develop and recommend effective indoor air pollution control methods and strategies	2	3	3	3	3	2	2			2			3	1	2
CEPE27	Health Safety and Environment	CO1	Identify and describe various environmental and occupational hazards	3	3	3	3	3								3	1	-
		CO2	Apply relevant health and safety regulations	3	3	3	3	3								3	1	-
		CO3	Implement strategies for managing and mitigating risks	3	3		3	3								2	1	-
		CO4	Suggest effective environmental, health, and safety audit programs	3	3		3	3								2	1	-
		CO5	Develop effective environmental pollution mitigation plans	1	3	3		3						1	1	2	2	-

3 - High; 2 - Medium; 1 - Low

Stream III: Geotechnical Engineering

3 - High; 2 - Medium; 1 - Low

Course code	Course Title	CO	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CEPE30	Advanced Foundation Engineering	CO1	Design cantilever and anchored sheet pile walls in various soil types using free and fixed earth support methods.	3	3	3	2	3	2	1	2	2	2	2	1	3	3	1
		CO2	Understand types and uses of cofferdams, and design cellular cofferdams using TVA and Cumming's methods.	3	3	3	2	2	2	2	2	1	1	1	1	3	2	1
		CO3	Analyse well foundations, determine scour depth, and design well sinking and staining thickness	3	3	3	3	3	2	2	2	2	2	2	1	3	1	2
		CO4	Design foundations for machines subjected to vibrations, applying vibration theory and IS code practices.	3	3	3	3	3	2	1	2	2	1	2	1	3	3	3
		CO5	Perform stability analysis for infinite and finite slopes using methods like Swedish circle, friction circle, and Taylor's stability number.	3	3	3	3	3	2	2	2	2	1	2	1	3	2	2
CEPE31	Geotechnical Earthquake Engineering	CO1	Ability to perform seismic hazard analysis and mitigation strategies	3	3	2	3	3	2	2	2	1	2	1	2	3	1	2
		CO2	Competence in analysing wave propagation in different soil conditions	3	3	2	3	3	2	1	1	1	2	1	2	3	3	2
		CO3	Proficiency in evaluating dynamic soil properties and ground response	3	3	3	3	3	2	1	2	1	2	1	2	2	2	1
		CO4	Capability to assess and mitigate liquefaction hazards	3	3	3	3	3	3	2	2	1	2	2	2	3	3	2
		CO5	Skill in applying codal provisions and conducting risk mapping and seismic micro-zonation	3	3	3	3	3	2	3	2	1	2	1	2	3	2	2

CEPE32	Reinforced Earth and Geotextiles	CO1	Students will understand the historical background and fundamental principles of reinforced earth and reinforced soil structures.	3	2	2	2	2	1	1	1	1	2	1	2	2	1	2
		CO2	Students will be able to describe the stress transfer mechanisms and modes of reinforcement action.	3	3	2	3	2	1	1	1	1	2	1	2	2	2	2
		CO3	Students will acquire detailed knowledge of geosynthetics, including geotextiles, geomembranes, geogrids, geonets, and geocomposites, and their applications.	3	3	3	3	3	1	1	1	1	2	1	2	3	2	2
		CO4	Students will learn the field application techniques and testing methods for reinforced earth structures.	2	3	3	3	3	2	2	1	1	2	2	2	3	2	1
		CO5	Students will be able to assess the behaviour of reinforced earth walls and understand soil-reinforcement interactions under various stability conditions.	3	3	3	3	3	3	2	1	1	2	2	2	3	2	2
CEPE33	Earth and Earth Retaining Structures	CO1	To understand the various approaches for analysing infinite and finite slopes.	3	3	2	2	2	1	1	1	1	2	1	2	1	2	2
		CO2	To conceive the estimation of active and passive earth pressure using different earth pressure theory including graphical methods.	3	3	2	2	2	1	1	1	1	2	1	2	2	2	2
		CO3	To design the rigid retaining wall and stability analysis for all kinds of drainage conditions.	3	3	3	2	2	1	2	1	1	2	1	2	3	2	2
		CO4	To design the sheet pile wall structurally to retain any type of soil and drainage conditions.	3	3	3	3	3	1	2	1	1	2	1	2	3	2	2
		CO5	To apply the knowledge on lateral earth pressure behind and around excavation to analyse and design braced excavations,	3	3	3	3	3	2	2	1	1	2	1	2	1	2	2

			slurry supported excavations and underground utilities.																
CEPE34	Marine Foundation Engineering	CO1	Recommend suitable offshore investigation techniques for the proposed project and able to provide appropriate soil design parameters	3	3	2	3	2	1	2	1	1	2	1	2	3	2	2
		CO2	Perform foundation analysis for gravity structures kind of offshore structures	3	3	3	3	2	1	2	1	1	2	1	2	3	2	2
		CO3	Perform foundation analysis for jacket kind of offshore structures	3	3	3	3	2	1	2	1	1	2	1	2	3	2	2
		CO4	Perform foundation analysis for jack-up kind of offshore structures	3	3	3	3	2	1	2	1	1	2	1	2	3	2	2
		CO5	Analysis suitable anchor system for mooring structures and able to provide foundation system for offshore pipeline.	3	3	3	3	2	2	2	1	1	2	1	2	3	3	3
CEPE35	Ground Improvement Techniques	CO1	To familiarize students with ground improvement techniques and their practical applications	3	2	3	2	2	1	2	1	1	2	1	2	3	2	1
		CO2	To apply various dewatering and consolidation techniques for different soil conditions	3	3	3	3	2	2	2	1	1	2	1	2	3	2	2
		CO3	To get exposed to and assess in-situ densification and stabilization techniques	3	3	3	3	2	2	2	1	1	2	1	2	3	2	2
		CO4	To understand reinforcement concepts and materials, including the mechanisms and applications of reinforced earth walls.	3	3	3	2	2	2	3	1	1	2	1	2	3	2	2
		CO5	To become familiar with grouting techniques and the stabilization of problematic soils.	3	3	3	3	2	2	3	1	1	2	1	2	3	2	2
CEPE36	Rock Mechanics	CO1	Demonstrate fundamental knowledge of rock mechanics and geological formations relevant to civil engineering projects.	3	2	2	1	1	1	1	2	1	2	1	2	3	2	1

		CO2	Apply laboratory and field-testing methods to determine the physical and mechanical properties of rocks.	3	3	2	3	2	2	1	1	1	2	1	2	2	3	1
		CO3	Classify rock masses using basic systems and understand the factors affecting slope stability.	3	2	2	1	1	2	3	1	1	2	1	2	2	3	1
		CO4	Explain various tunnelling techniques and the principles of tunnel support systems.	3	2	3	1	2	2	2	1	1	2	1	2	2	3	2
		CO5	Conduct basic stress analysis and understand the role of instrumentation in ensuring the safety and stability of tunnelling projects.	3	2	2	2	3	2	2	1	1	2	1	2	2	3	2
CEPE37	Geoenvironmental Engineering	CO1	To understand the various causes and how to safely dispose the waste through different containment process	3	2	2	1	2	3	3	2	1	2	1	2	3	2	2
		CO2	To understand the various mechanism of transport of contaminants into subsurface	3	3	2	2	2	2	3	1	1	2	1	2	3	2	2
		CO3	To understand the concept of soil and waste characterization techniques.	3	2	2	2	2	2	2	2	1	2	1	2	2	2	2
		CO4	To understand how to decontaminate the site to reuse the site for human settlement.	3	2	3	1	2	2	3	1	1	2	1	2	3	2	3
		CO5	To understand the consequences of soil waste interaction and its modifications.	3	2	2	2	2	3	3	2	1	2	1	2	3	2	3
CEPE38	Fundamentals of Geosynthetic Engineering	CO1	Understand the basic characteristics and functions of geosynthetics.	3	2	2	1	2	3	2	2	1	2	1	2	3	2	1
		CO2	Identify the various application areas of geosynthetics in engineering projects.	3	2	2	2	2	2	2	2	1	2	1	2	3	2	1
		CO3	Follow guidelines for the selection, installation, and maintenance of geosynthetics.	2	2	3	2	2	2	2	2	1	2	1	2	3	2	2
		CO4	Apply specific guidelines for the use of geosynthetics in various structures.	2	2	3	3	2	2	2	2	1	2	1	2	3	3	2

		CO5	Evaluate the quality and field performance of geosynthetics	2	2	2	2	3	2	2	2	1	2	1	2	3	3	2
CEPE39	Engineering Geology	CO1	Illustrate various properties of the minerals.	3	2	1	1	1	1	1	1	1	1	1	1	1	1	1
		CO2	Classify the rocks based on their physical properties.	2	3	2	2	2	2	1	1	1	1	1	1	2	1	1
		CO3	Identify folds, faults, unconformities, and joints associated with geological structures.	1	2	3	2	1	2	2	1	1	1	1	1	2	2	1
		CO4	Summarize the causes and effects of earthquakes and landslides.	1	2	2	3	1	2	2	1	1	1	2	1	1	1	1
		CO5	Select dam site based on the geological considerations	2	2	3	2	3	2	2	1	1	1	1	1	3	1	2

3 - High; 2 - Medium; 1 - Low

Stream IV: Geospatial Techniques

3 - High; 2 - Medium; 1 - Low

Course code	Course Title	CO	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CEPE40	Geodetic Surveying	CO1	Select the correct, best suited curve and set the curve on the road	3	3		1	3				2	2	2	1	1	3	2
		CO2	Apply geodetic methods such as Triangulation in baseline measurements and large area estimation	3	3		1	3				2	2	2	1	1	3	2
		CO3	Apply Trigonometric leveling in estimation of elevation in plane survey and geodetic observation	3	3		1	3				2	2	2	1	1	3	2
		CO4	Identify the errors present in the field observation and to adjust the errors using suitable methods	3	3		1					2	2	2	1	1	3	2
		CO5	Demonstrate the principles of the earth surface, its projections and different coordinates involved in map making	3	3		1	3				2	2	2	1	1	3	2
CEPE41	Advanced Surveying Techniques	CO1	Understand the different Advanced Surveying Techniques such as use of EDMs, Total Station, Digital Level in accurate measurement and Mapping Select the advanced technique which is best suited for a work	3	3		1	3				2	2	2	1	1	3	2
		CO2	Gain knowledge of use of Remote Sensing in Land use survey by understanding its principle and data interpretation keys	3	3		1	3				2	2	2	1	1	3	2
		CO3	Demonstrate the principles of the earth surface, its projections and different coordinates involved in map making	3	3		1	3				2	2	2	1	1	3	2
		CO4	Understand the working principle of GPS	3	3		1	2				2	2	2	1	1	3	2

			and different methods of measurement															
		CO5	Understand the importance and application of different advanced Surveying techniques in different areas of Civil Engineering through different case studies	3	3		1	3				2	2	2	1	1	3	2
CEPE42	Geodesy	CO1	Understand the different difference branches of Geodesy, Earth Shape, Reference surfaces, datum and their relationships for estimation of horizontal and vertical control	3	3	2		2		2		1	1	1	2	2		3
		CO2	Gain knowledge of global and local reference plans, coordinate systems for different countries and their utility in position mapping	3	3	1	2	3		1		1		1	2	3		
		CO3	Understand different map projections used with respect to location and county	1	2	3		1		1	2		1	2			3	
		CO4	Gain knowledge on Field astronomy and their importance in defining the position on coordinate system	2		2		1	1	1		1	3	2		1		2
		CO5	Understand the importance of space geodesy in civil engineering applications	2		1	2	1	1		2		2			3		1
CEPE43	Disaster Modelling and Management	CO1	Ability to define and classify various natural and man-made disasters, understanding their causes and effects.	3	3		1					2	2	2	1	1	3	2
		CO2	Proficiency in selecting appropriate modelling techniques for hazard prediction, considering scientific and engineering principles.	3	3		1	2				2	2	2	1	1	3	2
		CO3	Competence in assessing vulnerability and risk, and applying structural and non-	2	3	3	3	3	2	2	2		2			1	3	2

			structural mitigation strategies to reduce disaster impacts.															
		CO4	Skills to create and execute comprehensive emergency management plans, including early warning systems, evacuation plans, and effective communication strategies.	3	3		3	3		2			3	2		1	3	2
		CO5	Capability to apply remote sensing, GIS, and other technological tools for disaster risk and vulnerability mapping, and to analyse case studies for practical insights.	2	3	2	3	3	1	3			1	2	2	1	3	2
CEPE44	AI/ML& DL for Remote Sensing and GIS	CO1	Explain the fundamental principles and historical context of AI and ML.	3	2	1	3	2	3			2	1	2	2	3	2	1
		CO2	Implement and evaluate various machine learning algorithms and techniques.		2	3		1	2	2		3	2	2		3	2	1
		CO3	Develop and optimize linear classification models for regression and classification tasks.	2	3	2	3			2	3	1		1		2		2
		CO4	Design, train, and fine-tune deep neural networks for complex problem-solving.	3	2	3	3	2		3	2	3	2	3		1	2	1
		CO5	Apply AI/ML solutions to real-world challenges in areas like agriculture, environmental monitoring, and disaster response.	2	1	3	3	2	1	2	2		3	1	2		2	3
CEPE45	Geomatics in Water Resources Engineering	CO1	Have Sound fundamental understanding of the GIS and remote sensing technologies	3	3		1					2	2	2	1	2	2	1
		CO2	Understand the basic principles underlying the GIS based management of water resources and environment.	3	3		1					2	2	2	1	2	2	1
		CO3	Familiar with the GIS-based analytical and problem-solving techniques for sustainable planning and management of water resources and environmental problems.	3	3		1					2	2	2	1	2	2	1

		CO4	Understand types of remotely sensed images and data available for water resource applications.	3	3		1					2	2	2	1	2	2	1
		CO5	Develop a project report and can develop Water Resource Information Systems (WRIS) for regional and basin scale.	3	3		1	2				2	2	2	1	2	2	1
CEPE46	Advanced Geospatial Techniques	CO1	Show expertise in hyperspectral remote sensing, including spectral measurement	2	3	2	3	3	2	3	1	1	1	1	2		2	
		CO2	Apply LASER properties, Doppler LiDAR, and GPS synchronization to 3D urban modelling and mapping across platforms	3	3	3	3	3	2	3	1	2	2	3	3		1	
		CO3	Use thermal remote sensing data to separate temperature-emissivity and applications	3	3	3	3	3	2	3	1	2	2	2	3	3		2
		CO4	Analyze and interpret passive and active microwave radiometry data including SAR and polarimetric SAR.	3	3	3	3	3	2	3	1	2	2	2	3	3	2	
		CO5	Use various satellite images and advanced remote sensing techniques for environmental applications	3	3	3	3	3	3	3	1	2	3	3	3	3	2	1
CEPE47	Thermal and Hyperspectral Remote Sensing	CO1	Understand thermal radiation, and data gathering environmental conditions.	3	2	1	3	2	3			2	1	2	2	3	2	1
		CO2	Use thermal and hyperspectral sensors to acquire and preprocess remote sensing images.		2	3		1	2	2		3	2	2		3	2	1
		CO3	Getting idea about Hyper spectral remote sensing basics	2	3	2	3			2	3	1		1		2		2
		CO4	Interpret and compress data using hyperspectral remote sensing technologies	3	2	3	3	2		3	2	3	2	3		1	2	1
		CO5	Apply the geospatial and image processing techniques for various environmental problems.	2	1	3	3	2	1	2	2		3	1	2		2	3
CEPE48		CO1	Analyze remote sensing data to assess	3	2				2		2	1	3	2		2	1	2

	Application of Remote Sensing and GIS in Agriculture and Forestry		crop health, estimate crop yield.															
		CO2	Process and interpret radar data for various agricultural applications, including soil moisture retrieval, vegetation structure analysis.	3		2	3	2	3	2			3	2	2	1	3	1
		CO3	Getting an idea about Hyperspectral remote sensing and its application on crop monitoring		3	3		2		2	2		2	1	2	3	3	2
		CO4	Utilize remote sensing data for assessing crop losses, managing droughts, and applying agro-meteorological principles	3	2	2			1	2	1	2		2	3	3	3	1
		CO5	Apply the geospatial techniques for monitoring deforestation and forest management practices,	2	3		2	2		3	3	2	1	2		2	3	2

3 - High; 2 - Medium; 1 - Low

Stream V: Transportation Engineering

3 - High; 2 - Medium; 1 - Low

Course code	Course Title	CO	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CEPE50	Traffic Engineering and Safety	CO1	Carry out traffic surveys	3	3	1	3	3	2	1	1	3	1	3	1	2	3	2
		CO2	Implement traffic system management	3	3	3	2	3	1	3	1	3	1	2	1	3	3	1
		CO3	Carry out intersection design for safety	3	3	3	2	3	1	3	1	3	1	2	1	3	3	1
		CO4	Record and analyse accident data and suggest countermeasures	3	3	3	1	3	2	3	1	3	2	3	2	3	3	2
		CO5	Carry out road safety audit	3	3	3	1	3	2	3	1	3	3	3	2	3	3	2
CEPE51	Pavement Analysis and Design	CO1	Identify the pavement components and compare highway and airport pavements.	3	1						1	1				1	1	1
		CO2	Calculate the stresses and ESWL in flexible pavements.	3	3		2				1		2		1	2	1	1
		CO3	Design the flexible pavement using empirical, semi empirical and IRC methods	3	3	3	3	3	2	2	1			3	1	3	2	2
		CO4	Analyze the warping, friction, wheel load stress and calculate the combined stress.	3	3		2				1				1	2	1	1
		CO5	Design rigid pavements by IRC method and evaluate the pavements.	3	3	3	3	3	2	2	1	1		3	1	3	2	2
CEPE52	Transportation Planning	CO1	Apply the principles of the transportation planning process and demand estimation.	3	3		3		3		1			3		2	1	2
		CO2	Analyse the trip production and trip attraction models.	3	3		3	1	1		1	1		2		2	2	1
		CO3	Analyse the growth factor, gravity and opportunity models.	3	3		3	1	2		1				1	2	1	2
		CO4	Apply the mode choice behaviour and mode split models.	3		2	3		1	1	1	1	2		1	2	1	2
		CO5	Apply the shortest path models for route assignment	3		2		2	1		1	1	2	2		1	2	2
CEPE53		CO1	Compare the various urban modes and	2		1	2		3	2		1	2	2		2	1	1

	Urban Transportation Systems		service types															
		CO2	Quantify transportation demand and identify planning corridor	3	2	3	2	2	2	1			2	1	1	3	2	1
		CO3	Apply the concepts of transit scheduling	2	1	2	1	1		1	1		2	1		2	2	1
		CO4	Evaluate the planning aspects of terminals and depots	2		2	3	1	1	2	1	2	2	2		2	2	1
		CO5	Describe the concepts of integrated public transport planning	2	1	2	1		2	3			2	2		2	2	1
CEPE54	Intelligent Transportation Systems	CO1	understand the sensor technologies	3	2	2	2	3	2	2	1	1	2	1	2	2	2	1
		CO2	understand the communication techniques	3	3	2	2	3	2	2	1	1	2	2	3	2	3	1
		CO3	apply the various ITS methodologies	2	3	3	2	2	3	3	2	2	3	2	2	3	3	2
		CO4	understand the user needs	3	3	3	2	3	2	3	1	1	2	2	3	2	3	2
		CO5	define the significance of ITS from developed countries perspective and implications for Indian conditions	2	3	3	2	3	2	3	1	2	2	2	3	3	2	2
CEPE55	Pavement Management System	CO1	comprehend principles for evaluating pavement performance and assessing pavement distresses.	1	2		2				3		3	2	1			
		CO2	gain knowledge of pavement structure evaluation techniques and field tests	1	2		1		2		3		3	2	1			
		CO3	learn to develop and utilize performance prediction models for pavement management	3	1			2	2				1	1	1			
		CO4	utilize performance prediction models for pavement management	3	3		2	3							1			
		CO5	conduct life cycle cost analysis and optimize maintenance and rehabilitation strategies	3	3	2	2			3				3	3			
CEPE56	Pavement Material Characterisation	CO1	understand the properties and test procedures of aggregate		2		2		1		3		2	3				
		CO2	understand the properties of bituminous materials		2		2		1		3		2	3				
		CO3	perform bituminous mix design using	2	3	3	3	3					2	2				

			various methods															
		CO4	do PQC mix design and can conduct various tests on cement and concrete	2	3	3	3	3					2	2				
		CO5	use recycled and other materials in road construction		2	3	1		1	3			1	1	3			
CEPE57	Sustainable Transportation	CO1	specify transport planning strategies for sustainable development	3	2	2	1			3	2		2	2	1	3	2	2
		CO2	evaluate strategies for development of non-motorised transport	2	2	3	2	1	1	3	2		2	2		3	2	1
		CO3	specify actions for planning for pedestrian facilities	3	2	2	1		2	2		1	2	2		2	2	1
		CO4	specify actions for planning for bicyclists' facilities	3	2	2	1		2	2		1	2	2		2	2	1
		CO5	elaborate on sustainable policies and technologies	2	2	1	1		2	2	1		2	2	1	3	2	1

3 - High; 2 - Medium; 1 - Low

Stream VI: Structural Engineering

3 - High; 2 - Medium; 1 - Low

Course code	Course Title	CO	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CEPE60	Elementary Structural Dynamics	CO1	Demonstrate an understanding of the basic concepts of dynamic analysis and the elements of vibratory systems	3	3	3	3	2	1	1	1	2	1	3		3	2	1
		CO2	Develop and use mathematical models for single degree of freedom (SDOF) systems using the lumped mass procedure	3	3	3	3	3	1	1	1	2	1	3		3	3	1
		CO3	Formulate and solve equations of motion for MDOF systems, identifying natural frequencies, mode shapes, and orthogonality conditions	3	3	3	3	3	1	1	1	2	1	3		3	3	1
		CO4	Conduct deterministic analyses of earthquake responses for multi-storeyed frames using response spectra	3	3	3	3	3	1	1	1	2	1	3		3	3	1
		CO5	Apply approximate methods for dynamic analysis, including Rayleigh's method, Rayleigh-Ritz method	3	3	3	3	2	1	1	1	2	1	3		3	2	1
CEPE61	Maintenance and Rehabilitation of Structures	CO1	Diagnose the damage in distressed structures	3	1	2	2		1	1						2	-	1
		CO2	Conduct condition assessment of structures	3	1	2	2		1	1						2	-	1
		CO3	Select the proper repair materials and its application	3	1	2	2		1	1						2	-	1
		CO4	Select methods to strengthen distressed structures	3	1	2	2		1	1						2	-	1
		CO5	able to use proper demolition techniques w.r.t the requirements	3	1	2	2		1	1						2	-	1
CEPE62	Conceptual Design of Structures	CO1	To understand the importance of conceptual design of structures	2	3	1	3	2	3	3	1	3	3	3	1	2	3	1
		CO2	To interpret the structural behaviour from nature and the evolution of structural forms	2	3	1	3	2	3	3	1	3	3	3	1	2	3	1

		CO3	To create physical models of structures and learn the development of structural forms	2	3	1	3	2	3	3	1	3	3	3	1	2	3	1
		CO4	To learn the role of materials in shaping the structural forms, systems and analysis	2	3	1	3	2	3	3	1	3	3	3	1	2	3	1
		CO5	To get a hands-on experience on the conceptual design of structures	2	3	1	3	2	3	3	1	3	3	3	1	2	3	1
CEPE63	Prestressed Concrete Structures	CO1	Design a prestressed concrete beam accounting for losses	3	3	3	3						2			3	-	1
		CO2	Design the anchorage zone for post tensioned members	3	3	3	3						2		2	3	1	1
		CO3	Design prestressed composite members	3	3	3	3						2			3	-	1
		CO4	Design prestressed continuous beams	3	3	3	3						2			3	-	1
		CO5	Design prestressed water tanks	3	3	3	3						2			3	-	1
CEPE64	Advanced Reinforced Concrete Design	CO1	Apply the concepts of liquid retaining structures	3	2		1					1	2	1	1	1	1	1
		CO2	Design material storage structures using various theories	3	2		2					3	3	2	1	2	2	1
		CO3	Apply the concepts of environmental and transportation structures	3	2		1					1	2	1	1	1	1	1
		CO4	Demonstrate the detailing of reinforcement	3	1		2					3	3	2	1	1	2	1
		CO5	Draw the various RCC structures	3	1		1					3	3	2	1	1	2	1
CEPE65	Advanced Steel Structural Elements	CO1	Design eccentrically loaded compression members (Beam-Columns) and their base plates.	3	3	3	2	1								2	1	-
		CO2	Design welded plate girder and Gantry girder for industrial structures	3	3	3	2	1								2	1	-
		CO3	Calculate the wind load acting on various structures to be built in various locations.	3	3	3	2	1								2	1	-
		CO4	Design Industrial structures and their components such as girts, wind girders, bracings systems purlins etc.	3	3	3	2	1								2	1	-
		CO5	Design the moment resisting connections used in steel frames	3	3	3	2		1	2			1			2	1	-

CEPE66	Advanced Structural Analysis	CO1	Demonstrate the concepts of qualitative influence line diagram for continuous beams and frames.	3	3		2					1	2	1	2	2	1	1
		CO2	Apply the methods of indeterminate truss analysis.	3	2		3					1	2	1	2	2	1	1
		CO3	Demonstrate the behavior of arches and their methods of analysis.	3	3		2					1	2	1	2	2	1	1
		CO4	Analyse cable suspension bridges.	3	2		3					1	2	1	2	2	1	1
		CO5	Analyse multistory frames subjected to gravity loads and lateral loads	3	2		3					1	2	1	2	2	1	1
CEPE67	Design of Offshore and Coastal Structures	CO1	Gain knowledge on different types of offshore structures	3	3	3	2	2	1	1	1					3	2	2
		CO2	Understand the different types of loads acting on offshore structures	3	3	3	3	2	2	2	1	1				3	2	1
		CO3	Gain understanding on waves in shallow water, diffraction, reflection and diffraction	3	3	3	3	2	2	2	2	1	1			3	2	2
		CO4	Design breakwaters and other coastal defense structures	3	3	3	3	2	2	2	1	1				3	2	2
		CO5	Understand the concepts of littoral drift, wave forces and coastal erosion protection	3	3	3	3	2	2	2	1			1		2	2	1
CEPE68	Prefabricated Structures	CO1	Understand the behaviour of prefabricated structures	3	3	3	1	3	1			1	2	1	1	2	2	1
		CO2	Become familiar with the production of prefabrication units and erection process.	3	3	3	2	3	1			1	3	2	1	2	2	2
		CO3	Able to perform an industry relevant design project in a team setting	3	3	3	1	3	1			1	2	1	1	2	2	1
		CO4	Exhibit their knowledge in designing and detailing of prefabrication units	3	3	3	2	3	1			1	3	2	1	2	2	2
		CO5	Able to supervise production, transportation and erection of prefabricated units	3	3	3	1	3	1			1	3	2	1	2	2	2
CEPE69	Heritage Structures	CO1	Attain in-depth knowledge on various terminologies and methodology involved for heritage structure	2	2	3	2	1	2		1		3	2	2	2	2	2
		CO2	Familiarise the features and building bye-laws	1	1	2	1		3	2	3					2	-	3

		CO3	Visualise the correct preservative measures and methodology	2	1	2	1		3	1	2				1	2	1	2
		CO4	Attain in-depth knowledge about the adaptive reuse of heritage structures	2	2	3				3		2			2	3	1	-
		CO5	Familiarise about the various construction techniques Involved From the collected case Studies	2	2	2			1				3		2	1	1	2
CEPE70	Earthquake Resistant Structures	CO1	Apply the basics of Earthquake Engineering	3	3	3	1	3	1			1	2	1	1	2	2	1
		CO2	Demonstrate the dynamics of structural system under earthquake load	3	3	3	2	3	1			1	3	2	1	2	2	2
		CO3	Analyze the influence of the structural / geometrical design in building characteristics	3	3	3	1	3	1			1	2	1	1	2	2	1
		CO4	Demonstrate the cyclic loading behaviour of RC steel and pre-stressed concrete elements	3	3	3	2	3	1			1	3	2	1	2	2	2
		CO5	Apply Codal provisions on different types of structures	3	3	3	1	3	1			1	3	2	1	2	2	2
CEPE71	Steel Concrete Composite Structures	CO1	Apply the concepts of steel concrete composite in civil engineering construction and practices	3	3	3	1	3	1			1	2	1	1	2	2	1
		CO2	Analyse the behavior of shear connectors, degree of shear connection and development of composite action	3	3	3	2	3	1			1	3	2	1	2	2	2
		CO3	Design composite beams under propped and un-propped condition	3	3	3	1	3	1			1	2	1	1	2	2	1
		CO4	Design different types of composite deck slabs and columns.	3	3	3	2	3	1			1	3	2	1	2	2	2
		CO5	Analyse the effects of temperature, shrinkage and creep on composite design.	3	3	3	1	3	1			1	3	2	1	2	2	2
CEPE72	Metallurgy for Civil Engineers	CO1	To understand the importance of metallurgy for civil engineers	2	3	1	3	2	3	3	1	3	3	3	1	2	3	1
		CO2	To choose the correct type of materials, welding process and welding consumables in steel construction	2	3	1	3	2	3	3	1	3	3	3	1	2	3	1

		CO3	To familiarize with the various microstructures of steel under room temperature	2	3	1	3	2	3	3	1	3	3	3	1	2	3	1
		CO4	To learn the role of alloying metals and grain size in the mechanical properties of steel	2	3	1	3	2	3	3	1	3	3	3	1	2	3	1
		CO5	To know the types of stainless steel and the possibility of making green steel	2	3	1	3	2	3	3	1	3	3	3	1	2	3	1
CEPE73	Basic Bridge Engineering	CO1	To be familiar with the components of bridges, classification of bridges, importance of bridges	3	3	3	1	3	1			1	2	1	1	2	2	1
		CO2	To understand the specification of road bridges, loads to be considered	3	3	3	2	3	1			1	3	2	1	2	2	2
		CO3	To be familiar with various types of concrete bridges such as slab-bridge, T-beam bridge, pre-stressed concrete bridge	3	3	3	1	3	1			1	2	1	1	2	2	1
		CO4	To be familiar with various types of steel bridges such truss bridge and girder bridge	3	3	3	2	3	1			1	3	2	1	2	2	2
		CO5	To get exposed to evaluation of sub structures, type of foundations, importance of bearings	3	3	3	1	3	1			1	3	2	1	2	2	2
CEPE74	Advanced Mechanics of Solids	CO1	To learn the elastic and plastic behaviour of materials	3	3	1	2	1	1	1	1	1	1	1	1	2	1	1
		CO2	To understand principal stresses and Mohrs circles in 3D	3	3	1	2	1	1	1	1	1	1	1	1	2	1	1
		CO3	To get exposed to unsymmetrical bending of beams	3	3	1	2	1	1	1	1	1	1	1	1	2	1	1
		CO4	To familiarize with the analysis of curved beams	3	3	1	2	1	1	1	1	1	1	1	1	2	1	1
		CO5	To know the fundamentals of vibration and resonance	3	3	1	2	1	1	1	1	1	1	1	1	2	1	1
CEPE75	Optimisation Techniques in Civil Engineering	CO1	Formulate engineering design problem as an optimization problem.	3	2	3	2	3	2	2	2	3	2	3	2	2	3	2
		CO2	Apply suitable optimization technique to the design problem at hand.	3	3	2	2	3	2	2	2	3	2	3	2	2	3	1

		CO3	Evaluate the problem as linear or nonlinear optimization problem and design the optimization technique.	2	2	2	1	2	1	1	1	2	1	2	2	1	3	1
		CO4	Evaluate the problem as single variable or multi-variable optimization problem and design the corresponding optimization technique	2	1	1	1	2	1	1	1	2	1	3	2	2	2	1
		CO5	Formulate linear programming problem for engineering applications and evaluate the solution.	2	1	1	1	2	1	1	1	2	1	2	2	1	2	1
CEPE76	Introduction to Finite Element Methods	CO1	Demonstrate a comprehensive understanding of the basic concepts of finite element analysis (FEA) and its development, with a particular emphasis on stress analysis.	2	3	2	3	3	2	2	1	2	2	2	3	3	2	1
		CO2	Formulate and transform element force-displacement relations using flexibility and stiffness methods, and understand transformations between flexibility and stiffness	2	3	3	2	3	1	2	1	1	2	1	2	3	2	1
		CO3	Execute the direct stiffness method, including its basic concepts and general procedures, for global analysis in FEA	2	2	2	3	2	1	1	1	2	1	2	3	3	3	1
		CO4	Formulate element force-displacement relations using the direct method and variational principles	2	1	2	2	3	1	1	1	2	1	2	2	3	3	1
		CO5	Develop and utilize element behavior functions, including polynomial series for 2D rectangular elements, and construct shape functions through interpolation using natural coordinates	2	3	2	2	3	1	1	1	1	1	1	3	3	2	1
CEPE77	Structural Health Monitoring	CO1	Demonstrate a comprehensive understanding of the basic principles of SHM.	2	2	2	2	1	3	1	1	2	2	1	3	3	3	2

		CO2	Identify and apply the appropriate sensors and instrumentation for various SHM applications	1	1	2	1	1	2	2	1	3	3	1	2	1	1	2
		CO3	Execute static and dynamic measurement techniques to detect and assess structural damage effectively	1	1	1	1	1	2	3	1	3	2	1	1	1	1	2
		CO4	Employ advanced signal processing methods to process SHM data, and analyze the structural integrity of various infrastructures	1	2	2	2	3	1	1	1	3	2	2	2	3	3	2
		CO5	Critically analyze case studies involving the SHM of large-scale structures, optimize sensor placement, and develop strategies	1	2	2	1	1	2	3	1	3	2	1	3	3	1	2
CEPE78	Introduction to Matrix Method of Structural Analysis	CO1	Understand and apply basic matrix algebra to structural analysis problems.	3	3	2	1	3	1	1	1	2	2	2	3	3	3	1
		CO2	Develop and assemble local and global stiffness matrices for structural elements like beams, trusses, and frames.	3	3	2	1	3	2	1	1	2	1	1	3	3	2	1
		CO3	Solve systems of linear equations to find displacements, member forces, and support reactions in structures.	3	2	2	2	3	1	1	1	2	1	1	3	3	3	1
		CO4	Apply matrix methods to analyze trusses and frames, accounting for various forces and support conditions.	3	2	2	2	2	2	2	1	2	1	2	3	3	3	1
		CO5	Use structural analysis software to analyse and interpret real-world structural problems.	3	2	2	2	2	2	2	1	2	1	2	3	3	3	1

3 - High; 2 - Medium; 1 – Low

Stream VII: Water Resources Engineering

3 - High; 2 - Medium; 1 - Low

Course code	Course Title	CO	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CEPE80	Ground Water Hydrology	CO1	Identify types of aquifers	3	3	2	2	1	1				2	2	2	2	2	1
		CO2	carry out surface and subsurface investigation to locate groundwater	3	2	2	2		2	1				2		2	1	1
		CO3	visualize the occurrence and movement of groundwater	3	2	3	2		2	2		2		2		3	2	1
		CO4	select suitable type of ground water recharge	3	2	2	1			2			2		2	2	1	1
		CO5	Assess sea water intrusion and its control						2							-	-	1
CEPE81	Applied Hydraulics Engineering	CO1	Acquire specific knowledge regarding fluid flow phenomena observed in Civil Engineering systems such as flow in open channel flow	3	3	2		1		1		1		1	1	2	1	-
		CO2	Develop understanding of the basic principles of fluid flow patterns and boundary layer theory and provide skills in analyzing fluid flows in open channel hydraulics	3	3	2		1		1		1		1	1	2	1	-
		CO3	Understand gradually varied flow profile in detail.	3	2	1		2		1		1		1	1	2	2	-
		CO4	Understand rapidly varied flow profile in detail	3	2	3		1		2		1		1	1	2	1	-
		CO5	Knowledge is useful for the design of open channels for rectangular and non-rectangular channels for hydraulic jump phenomena.	3	2	3		1		1		1		1	1	2	1	-
CEPE82	Simulation Modelling for Water	CO1	To build on the student's background in basics of simulation modelling.	3	3	2		1		1		1		1	1	2	1	-
		CO2	To develop the skills in modelling of linear	3	3	2		1		1		1		1	1	2	1	-

	Resources Engineering		and nonlinear regression.															
		CO3	To learn about dynamic programming techniques for water allocation and distribution networks.	3	2	1		2		1		1		1	1	2	2	-
		CO4	To develop skills in the artificial intelligence tools such as fuzzy systems, neural networks and genetic programming.	3	2	3		1		2		1		1	1	2	1	-
		CO5	To provide wide knowledge on optimization tools.	3	2	3		1		1		1		1	1	2	1	-
CEPE83	Coastal Engineering	CO1	Develop knowledge in basics of wave hydrodynamics	3	3	2		1		1		1		2	1	2	2	-
		CO2	Provides understanding various aspects of coastal engineering	3	3	2		1		1		1		2	1	2	2	-
		CO3	Describes wave forces, wave pressures and currents in the coastal areas.	3	2	1		2		1		1		1	1	2	2	-
		CO4	Improves knowledge on sea defence structures	3	2	3		1		2		1		1	1	2	1	-
		CO5	Develop knowledge in basics of wave hydrodynamics	3	2	3		1		1		1		2	1	2	2	-
CEPE84	Surface water hydrology	CO1	To understand the fundamental principles of hydrology and analyze the precipitation.	3	2	1	2	1		1			1		1	1	1	2
		CO2	To understand the processes and significance of hydrologic abstractions in the hydrological cycle.	3	1	2	1	1	2	3			1	1		1		2
		CO3	To apply techniques for streamflow measurement and analyze runoff characteristics and volume.	3	2	3	2	2	1	2	1	1	1	1	1		1	1
		CO4	To develop, and analyze the components of hydrographs using various methods.	2	2	3	2	2		1	1		2		2	2	1	1
		CO5	To conduct flood frequency and apply flood routing techniques for flood analysis.	3	2	3	2	3		2	1	1	2		2	1		1
CEPE85	AI /ML for water	CO1	Describe AI and its applications in civil engineering.	2	3	2	3	2	3	2	2	3	1	3	3	1	3	3

	Resources Engineering	CO2	Implement ANN to solve water resource problems like rainfall prediction.	2		1	3	3	2	3	2	3	2	3	3	2	1	2
		CO3	Apply genetic algorithms for optimizing water distribution and irrigation.	3	2		2		3		3	3	2	2	3	2		1
		CO4	Use fuzzy logic for reservoir operations and flood predictions.	2	3	2	3	3		2	3	3	2	3		3	2	
		CO5	Use machine learning and IoT in smart irrigation and water supply systems.	1	3	3		2	3	3	2	1	2	3	2	1		2
CEPE86	Hydroclimatology	CO1	Describe the carbon cycles, greenhouse gases, and greenhouse effects.	3	2	2	2	3	2	1	3		3	3		2	3	2
		CO2	Develop and assess climate models, understanding their simulations and regional impacts.	1	2	1	1		2		2	3		2		3	2	2
		CO3	Analyse the effects of climate change on precipitation, runoff, groundwater, and sea levels.	2	3	3	3	3		3		2		1		2	2	2
		CO4	Use various models to project climate scenarios, calibrate, validate, and develop adaptation strategies.	3		3	2	2		3		2	2	1	2	3		3
		CO5	Conduct risk assessments for floods and droughts, analyse rainfall trends, and evaluate sediment impacts on water resources.	3	2	2	3		2	2	3	1	2	3	3	2	1	2
CEPE87	River Engineering	CO1	Understand the basics of River engineering.	3	3	2	2	2	2	2	1	2	1	2	2	2	1	2
		CO2	Understand the concepts of River behavior.	3	3	2	2	2	2	2	1	2	1	2	2	2	1	2
		CO3	Computer river morphology.	3	3	3	3	3	2	2	1	2	2	3	2	3	2	3
		CO4	Understand the unsteady flow process in River.	3	3	2	3	2	2	2	1	2	2	3	2	3	1	3
		CO5	Understand about different types of River training works.	3	3	3	3	3	2	2	1	2	2	3	2	3	2	3
CEPE88	Watershed Management	CO1	To describe the hydrological cycle, watershed components, and their roles in	1	1	1	1	1		3	1	1	2	1	3		2	3

			hydrology and urban planning.															
		CO2	To apply BMPs for water management and create a watershed management plan with stakeholder involvement.	1	2	3	2	1	3	3	1	1	2		2	1		3
		CO3	To implement erosion control and water conservation practices to improve land and water management.	1	2	3	3	1	3	3	1	1	3	1	2	1	1	3
		CO4	To comprehend and apply key watershed management policies, regulations, and the roles of various agencies.		1	1	2	1	3	3	2	2	3	2	1	1	1	3
		CO5	To use new technologies in watershed management and address climate change impacts with adaptive strategies.	2	2	3	3	3	2	3	2	2			3		3	1
CEPE89	Water Resource Systems Planning	CO1	Apply concepts of systems analysis for planning of water resources systems	3	1	2	1	2		2	1		1		1	1	1	2
		CO2	Perform basic economic analysis to evaluate the economic feasibility of water Resources projects	3	1	2	1	1	3	3			1	1		1		2
		CO3	Formulate and solve deterministic optimization models for design and operation of water resources systems	3	1	2	2	2	1	1	1	1	1	1	1		1	1
		CO4	Formulate and solve stochastic and fuzzy optimization problems for decision making under uncertainty	2	1	2	2	2		2	2		2		2	2	1	1
		CO5	Application of optimisation and simulation techniques in water resources engineering	2	1	3	3	3		2	2	2	1		1	1		1

3 - High; 2 - Medium; 1 – Low

OPEN ELECTIVES (PE)

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

3 - High; 2 - Medium; 1 - Low

Course code	Course Title	CO	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CEOE10	Remote Sensing and GIS	CO1	Demonstrate the concepts of Electro Magnetic energy, spectrum and spectral signature curves.	3	3	3	2	1	2		1		3	2	2	2	2	2
		CO2	Apply the concepts of satellite and sensor parameters and characteristics of different platforms.	3	1	2	1		3	2	2					2	-	2
		CO3	Apply the concepts of DBMS in GIS.	3	1	2	1		3	1	3				1	2	1	3
		CO4	Analyze raster and vector data and modeling in GIS.	3	3	3				3		2			2	3	1	-
		CO5	Apply GIS in land use, disaster management, ITS and resource information system.	3	3	2			1				3		2	2	1	2
CEOE11	Ocean Energy	CO1	Understand the basics of ocean energy sources	3	3	2		1		1		1		1	1	2	1	-
		CO2	Capable of understanding the concepts of measurements of current and tides by using measuring devices	3	3	2		1		1		1		1	1	2	1	-
		CO3	Understand the different types of marine turbines	3	2	1		2		1		1		1	1	2	2	-
		CO4	Improves knowledge on water turbines, Electrical operations and marine safety	3	2	3		1		2		1		1	1	2	1	-
		CO5	Understand OTEC	3	2	3		1		1		1		1	1	2	1	-
CEOE12	Urban and Regional Planning	CO1	Demonstrate the various process involved in urban planning	3	3	3	1	2	2	1		3	2	1		2	2	1
		CO2	Apply the laws and governmental policies related to the planning process	3	3	3	2	2	2		1	3	2	1		2	2	2
		CO3	Implement the classical urban planning principles	3	3	3	2	2	2	1	1	2	2	1		2	1	2

Course code	Course Title	CO	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
		CO4	Apply the methods of financing of plans	3	3	3	2	2	2	1	1	2	1	1		3	2	2
		CO5	Demonstrate the regulations and by-laws	3	3	2	1	2	3	1		1	2		1	3	2	
CEOE13	Experimental Stress Analysis	CO1	Identify the different types of strain gauges	3	3	3	1	3	1			1	2	1	1	2	2	1
		CO2	Carry out model analysis	3	3	3	2	3	1			1	3	2	1	2	2	2
		CO3	Apply the concepts of photo elastic coatings	3	3	3	1	3	1			1	2	1	1	2	2	1
		CO4	Analyze the behavior of 2-D photo elasticity	3	3	3	2	3	1			1	3	2	1	2	2	2
		CO5	Apply the working principles of transducers	3	3	3	1	3	1			1	3	2	1	2	2	2
CEOE14	Sustainable Infrastructure	CO1	Understand the values and societal importance of the built environment	3	3	3	2	2		1	1			1	1	3	3	2
		CO2	Understand the influence on a sustainable development	3	3	3	2	2	2		1	1		1	1	3	2	2
		CO3	Gain knowledge on how to use environmental impact assessments as a tool for design	3	3	3	3	2	2	1		1		1		3	2	1
		CO4	Construction and management of a sustainable built environment	3	3	3	3	2	2	2	1		1		1	3	2	2
		CO5	Comprehend the aspects of social sustainability in the construction industry	3	3	3	2	2	2	1	2	1	2	1	1	3	2	2
CEOE15	Disaster Modelling and Management	CO1	Ability to define and classify various natural and man-made disasters, understanding their causes and effects.	3	3		1					2	2	2	1	1	3	2
		CO2	Proficiency in selecting appropriate modelling techniques for hazard prediction, considering scientific and engineering principles.	3	3		1	2				2	2	2	1	1	3	2
		CO3	Competence in assessing vulnerability and risk, and applying structural and non-structural mitigation strategies to reduce disaster impacts.	2	3	3	3	3	2	2	2		2			1	3	2
		CO4	Skills to create and execute comprehensive emergency management plans, including	3	3		3	3		2			3	2		1	3	2

Course code	Course Title	CO	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
			early warning systems, evacuation plans, and effective communication strategies.															
		CO5	Capability to apply remote sensing, GIS, and other technological tools for disaster risk and vulnerability mapping, and to analyse case studies for practical insights.	2	3	2	3	3	1	3			1	2	2	1	3	2
CEOE16	Standardization and Conformity Assessment	**CO1**	Explain the evolution of standards and standardization and the impact of standardization.	2	2	2	2	1	-	2	2	-	-	2	2	2	1	2
		CO2	Describe the various systems of standardization and apply the concepts of strategic management.	3	3	2	2	2	-	2	2	-	-	3	2	2	2	2
		CO3	Explain the BIS Act and organizational structure and assess the importance of standards in various sectors.	2	2	3	3	1	-	2	3	-	-	3	2	3	2	3
		CO4	Explain the compulsory registration scheme (CRS), deliver the importance of BIS certification and conformity assessment for products.	1	2	2	3	1	-	2	3	-	-	3	2	2	1	2
		CO5	Define the fundamentals of conformity assessment and apply the theoretical knowledge through practical applications.	2	2	2	2	2	-	2	3	-	-	3	3	2	2	2
CEOE17	Computational Fluid dynamics	CO1	Derive and analyze flow governing equations for various fluid dynamics.	2	3	2	2	2	2	2	1	2	2	2	2	2	2	2
		CO2	Implement and evaluate turbulence and multiphase flow modeling techniques.	2	3	2	2	2	2	2	1	2	2	2	2	2	2	2
		CO3	Discretize governing equations using finite volume methods for accurate solutions.	2	2	2	2	3	2	2	1	2	2	2	2	2	3	2
		CO4	Solve discretized equations with direct, iterative, and advanced numerical methods.	2	2	2	2	3	3	2	1	2	2	2	2	2	3	2
		CO5	Design structured and unstructured grids;	2	2	2	2	3	3	2	1	2	2	2	2	2	3	2

			perform benchmarking and calibration.															
CEOE18	Hydroinformatics	CO1	Describe sensor types, resolutions, and perform geospatial analysis using raster and vector data.	2	2	3	3	3	2	2		1	2	2	3	2	2	
		CO2	Implement data-driven modelling and machine learning techniques in Matlab and Python.	3	2	2		3	3	2	3	1	2	2	1		3	3
		CO3	Use statistical and machine learning models to solve practical hydroinformatics problems.	3	3	3	2	2	1	3	2	1	2	2	3	3	3	2
		CO4	Apply clustering and multivariate analysis techniques to complex datasets.	3	3	2	1	2	2	2	1	3			2	3	2	
		CO5	Conduct impact assessments for climate change and flood frequency using hydroinformatics methods.	3			2	3		1	2	3	2	1	3	3	2	2
CEOE19	Reliability methods	CO1	Demonstrate the ability to apply basic statistical methods and probability theory to analyze structural safety and performance.	2	2	1	2	2	1	2	1	3	2	3	3	2	2	1
		CO2	Analyze and interpret resistance distributions and statistical parameters for materials like concrete and steel.	2	2	2	2	2	1	1	1	2	2	2	3	2	2	1
		CO3	Compute the reliability of structural components using various methods	2	2	2	1	3	3	1	1	3	2	1	2	3	2	2
		CO4	Evaluate reliability indices for simple structural problems viz., beams, trusses.	3	1	2	2	3	3	1	1	3	2	1	2	3	2	2
		CO5	Apply reliability methods to solve practical civil engineering problems, ensuring the safety and performance of structures.	2	3	2	2	3	2	1	2	2	1	2	3	2	2	1
CEOE20	Uncertainty Modelling, Analysis and Quantification	CO1	Represent mathematically the uncertainty in the parameters of physical models.	3	3	2	1	3	1	1	1	2	2	2	3	3	3	1
		CO2	Propagate parametric uncertainty through physical models to quantify the induced uncertainty on quantities of interest.	3	3	2	1	3	2	1	1	2	1	1	3	3	2	1

		CO3	Develop and implement models for representing random fields and their uncertainties.	3	2	2	2	3	1	1	1	2	1	1	3	3	3	1
		CO4	Combine multiple sources of information to enhance the predictive capabilities of models	3	2	2	2	2	2	2	1	2	1	2	3	3	3	1
		CO5	Apply methods to quantify the uncertainties in a system	3	2	2	2	2	2	2	1	2	1	2	3	3	3	1

3 - High; 2 - Medium; 1 - Low

MINORS (MI)

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

3 - High; 2 - Medium; 1 - Low

Course code	Course Title	CO	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CEMI10	Construction Technology	CO1	Distinguish the different construction materials and select appropriate materials for construction	3	2				2	2		1	1			2	1	1
		CO2	Design suitable concrete mixes and test the concrete		2	3	3	2	1					2		2	1	1
		CO3	Execute construction jobs with the knowledge of the different construction techniques			3	3		2	2	1				2	2	1	2
		CO4	Comprehend the different types of building finishes and gain the ability to supervise the execution of different building services	3	3		2	2								2	1	-
		CO5	Identify the building defects and apply suitable repair techniques to rectify them	1	1	3	2	2			2	1						1
CEMI11	Surveying Practices	CO1	Carry out preliminary surveying in the field of civil engineering	3	3		1					2	2	2	1	2	2	1
		CO2	Plan a survey, taking accurate measurements, field booking, plotting and adjustment of traverse	3	3		1					2	2	2	1	2	2	1
		CO3	Use various conventional instruments involved in surveying with respect to utility and precision	3	3		1					2	2	2	1	2	2	1
		CO4	Plan a survey for applications such as road alignment and height of the building	3	3		1					2	2	2	1	2	2	1
		CO5	Undertake measurement and plotting in civil engineering	3	3		1	3				2	2	2	1	2	2	1
CEMI12	Structural Analysis and Design	CO1	Analyse and design simple structural elements	3	3	3	1	3	1			1	2	1	1	2	2	1
		CO2	Analyse and design simple axially loaded	3	3	3	2	3	1			1	3	2	1	2	2	2

Course code	Course Title	CO	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
			RC columns and beams															
		CO3	Analyse and design simple axially loaded Steel columns and beams	3	3	3	1	3	1			1	2	1	1	2	2	1
		CO4	Able to carry out simple bolted lap and butt joints	3	3	3	2	3	1			1	3	2	1	2	2	2
		CO5	able to carry out simple welded lap and butt joints	3	3	3	1	3	1			1	3	2	1	2	2	2
CEMI13	Soils and Foundations	CO1	Students will be able to classify various soil types.	3	3	2	1	1	1	2	1	0	0	1	0	1	1	1
		CO2	Students will be able evaluate appropriate soil compaction methods for different soil types.	2	3	3	2	1	2	1	1	0	1	2	0	1	2	1
		CO3	Students will be to analyze soil slope stability and understand failure mechanisms	2	2	3	1	1	1	2	2	0	0	1	0	1	1	1
		CO4	Students will be able to interpret the data obtained, and integrate the findings into practical engineering solutions for construction and soil improvement.	2	2	2	3	1	2	2	1	1	1	2	0	1	2	1
		CO5	Students will be able to determine soil suitability for foundations and other engineering applications.	2	2	3	2	1	1	2	1	0	1	1	0	3	2	2
CEMI14	Transportation Systems	CO1	Design cross section elements, sight distance, horizontal and vertical alignment	3	3		3		3		1			3		2	1	2
		CO2	Determine the characteristics of pavement materials	3	3		3	1	1		1	1		2		2	2	1
		CO3	Plan the layout of railway terminals	3	3		3	1	2		1				1	2	1	2
		CO4	Apply principles of airport planning	3		2	3		1	1	1	1	2		1	2	1	2
		CO5	Implement the layout of harbours	3		2		2	1		1	1	2	2		1	2	2
CEMI15	Water and Air Pollution	CO1	identify the source of water and to calculate water demand.	2	2		2	2								1	1	-

Course code	Course Title	CO	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	Management	CO2	apply the water treatment concept and methods.	2	2	3	2	1								2	1	-
		CO3	prepare a layout of water distribution network.	1	1	1	2	3								1	1	-
		CO4	characterize wastewater and apply suitable treatment process	2	2	3	3	3	1					2		2	2	1
		CO5	apply the various air pollution control devices to minimize the release of harmful gases into the atmosphere	2	2	2	2	2								2	1	-
CEMI16	Irrigation Engineering and Management	CO1	Find the crop water requirement for various crops in the command area.	3	3	2		1		1		1		1	1	2	1	-
		CO2	Understand the complete design of Dams and channel systems.	3	3	1		2		1		2		1	1	2	2	-
		CO3	Understand the different types of cross drainage works.	3	2	1		2		1		2		1	1	2	2	-
		CO4	Understand the participatory irrigation management	3	1	3		1		2		2		1	1	2	2	-
		CO5	Capable of designing reservoir storage characteristics	3	1	3		1		1		1		1	1	2	1	-
CEMI17	Quantity Estimation and Valuation	CO1	Apply different types of estimates in different situations	3	3	1	1	3	2	2	3	2	2	3	1	2	3	3
		CO2	Carry out analysis of rates and bill preparation at different locations	3	3	1	1	3	2	2	2	2	1	1	3	2	3	2
		CO3	Demonstrate the concepts of specification writing	3	3	3	1	1	1	1	1	1	1	1	3	2	2	1
		CO4	Carry out valuation of assets	3	3	3	2	2	2	2	1	1	1	1	3	3	2	2
		CO5	Able to write reports on the estimation of key construction structures	1	1		3				2		3	3			2	1

3 - High; 2 - Medium; 1 - Low

ESSENTIAL LABORATORY REQUIREMENT (ELR)

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

3 - High; 2 - Medium; 1 - Low

Course Code	Course Title	CO	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CELR10	Building Planning and Drawing	CO1	To apply fundamental principles of building planning to design functional and aesthetically pleasing structures that comply with relevant building bylaws and standards.	3	2	3	1	2	2	2	1	1	1	1	1	3	2	2
		CO2	.Proficient in creating and interpreting architectural drawings, including floor plans, elevations, sections, and construction details, using both manual and CAD techniques.	2	2	2	2	3	1	1	1	1	3	1	2	2	3	1
		CO3	Ability to plan and design various types of buildings, considering specific requirements for residential, commercial, and industrial structures.	3	2	3	2	2	2	2	1	1	1	2	1	3	2	2
		CO4	Integrating functional, aesthetic, and environmental considerations into building designs, promoting efficiency and sustainability in construction projects.	2	2	2	2	2	3	3	1	1	1	1	2	3	2	2
		CO5	Develop skills necessary to prepare comprehensive working drawings and detailed drawings for different building components	2	2	2	2	3	1	1	1	1	3	1	2	2	3	1
CELR11	Survey Laboratory	CO1	Use conventional surveying tools such as chain/tape, compass, plane table, level in the field of civil engineering applications such as structural plotting and highway profiling.	3	3		1					2	2	2	1			
		CO2	Apply the procedures involved in field work	3	3		1					2	2	2	1			

			and to work as a surveying team.															
		CO3	Plan a survey appropriately with the skill to understand the surroundings.	3	3		1					2	2	2	1			
		CO4	Take accurate measurements, field booking, plotting and adjustment of errors can be understood.	3	3		1					2	2	2	1			
		CO5	Understand the use of Conventional Surveying and Advanced Surveying techniques in practical applications of civil engineering	3	3		1	3				2	2	2	1			
CELR12	Fluid Mechanics Laboratory	CO1	Measure discharge in pipes	3	1	1	2				1	1		2	2			1
		CO2	Determine the energy loss in conduits	3	2	1	1		1		1	1		2	2			2
		CO3	Demonstrate the characteristics curves of pumps	3	2	3	3	1	1		1	1	1	2	3			2
		CO4	Demonstrate the characteristics curves of turbines	3	2	3	3	1	1		1	1	1	2	3			2
		CO5	Carry out discharge measurements in open channel	3	1	2	2	1		2	1	1		1	3			2
CELR13	Strength of materials and concrete Laboratory	CO1	Evaluate Young Modulus, torsional strength, hardness and tensile strength of given specimens.	3	3		1					2	2	2	1			
		CO2	Determine the strength of coarse aggregates.	3	3		1					2	2	2	1			
		CO3	Design concrete mixes and find the compressive strength of concrete cubes and bricks.	3	3		1					2	2	2	1			
		CO4	Find stiffness of open coiled and closed coiled springs.	3	3		1					2	2	2	1			
		CO5	Determine the physical properties of given coarse aggregates, fine aggregates and cement samples.	3	3		1	3				2	2	2	1			
CELR14	Geotechnical Engineering Laboratory	CO1	Students will classify soil types accurately based on index properties and assess their suitability for construction applications.	3	3	2	1	1	1	2	1	2	1	2	0	1	1	1

		CO2	**S**tudents will measure and interpret the consistency limits and compaction characteristics of soils effectively.	2	2	2	2	1	1	1	1	2	1	2	0	1	2	1
		CO3	Students will perform and analyze tests to estimate soil shear strength parameters required for engineering design.	3	3	2	3	2	2	2	2	1	1	2	0	1	1	1
		CO4	Students will estimate and evaluate the engineering properties of soils, such as density, permeability, and California Bearing Ratio (CBR), using appropriate tests.	3	2	2	3	2	2	2	1	1	2	2	0	2	2	1
		CO5	Students will integrate and interpret the results from various soil tests to provide comprehensive evaluations of soil behavior and suitability for construction.	3	2	3	3	3	2	2	2	1	1	2	0	3	2	2
CELR15	Environmental Engineering Laboratory	CO1	analyze physical characteristics of water and wastewater	3	3		1					2	2	2	1			
		CO2	quantify the inorganic solids in water	3	3		1					2	2	2	1			
		CO3	estimate organic fraction in wastewater	3	3		1	3				2	2	2	1			
		CO4	assess the microbial contamination in water	3	3		1					2	2	2	1			
		CO5	recommend the degree of treatment required for the water and wastewater	3	3		1					2	2	2	1			
CELR16	Transportation Engineering Laboratory	CO1	Conduct various traffic surveys	3	3		3		2			2	2	3	1	2	1	2
		CO2	Collect traffic data	3	2		3					2	2	2	1	3	1	2
		CO3	Perform laboratory tests on aggregate and bitumen	3	2		2					2	2	2	1	3	1	2
		CO4	Conduct mix design for GSB	3	2		3					2	2	2	1	3	1	2
		CO5	Carry out mix design for Bituminous mixes	3	3		3					2	3	2	1	3	1	2
CELR17	Computational Laboratory	CO1	To learn the software developing skills for structural design.	2	2	2	2	3	2	2	2	3	2	2	3	2	2	2
		CO2	To understand the computing techniques in the field of transportation	2	2	3	2	3	1	2	1	2	2	2	3	2	2	1
		CO3	To gain knowledge in problem solving in water resources.	2	2	3	2	3	1	2	1	2	2	1	3	2	2	1

		CO4	To learn the software skills in geotechnical engineering, GIS and Remote Sensing.	3	3	3	2	3	2	2	2	3	3	3	3	2	3	1
		CO5	To understand the computing techniques in construction management and project scheduling.	2	2	3	1	2	2	2	3	3	1	2	2	2	3	2

3 - High; 2 - Medium; 1 - Low

HONORS (HO)

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

3 - High; 2 - Medium; 1 - Low

Course Code	Course Title	CO	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CEHO10	Dynamics of Structures	CO1	Apply the concepts of dynamic systems	2	1	1	1	3	2	1								
		CO2	Identify, formulate and solve dynamic response of SDOF	3	2	1	1	2	2	1								
		CO3	Identify, formulate and solve dynamic response of MDOF	2	1	1	1	1	2	1								
		CO4	Analyze continuous systems subjected to different types of dynamic loads	2	2	1	1	2	2	1								
		CO5	Identify, formulate and solve free and forced vibrations response of structural systems	3	2	3	1	3	2	1								
CEHO11	Finite Element Analysis	CO1	Demonstrate the differential equilibrium equations and their relationship	2	1	1	1	3	2	1								
		CO2	Apply numerical methods to FEM	3	2	1	1	2	2	1								
		CO3	Demonstrate the displacement models and load vectors	2	1	1	1	1	2	1								
		CO4	Compute the stiffness matrix for isoperimetric elements	2	2	1	1	2	2	1								
		CO5	Analyze plane stress and plane strain problems	3	2	3	1	3	2	1								
CEHO12	Theory of Elasticity and Introduction to Plasticity	CO1	Relate various stress and strain measures and perform transformation between different bases.	3	2	1	1			1			1		1	1	1	1
		CO2	Determine principal, hydrostatic and octahedral stresses for given stress state	3	1	2	1			1			2		1	1	2	1
		CO3	Obtain the solution to classical problems	3	3	2	1		1	1			3		2	1	2	1

			using the Airy stress function approach															
		CO4	Analyse non-circular and open sections subjected to torsion	3	2	3	1		1	1			3		1	1	2	1
		CO5	Apply hardening rules in the plastic range and determine the failure of brittle and ductile materials using various failure theories.	1	1	1	3	2		1	2	3		2	2	3	3	2
CEHO13	Nonlinear Analysis of Structures	CO1	Identify the factors affect the nonlinear response of structures	2	1	1	1	3	2	1								
		CO2	Analyze the elastic-plastic properties of trusses, beams and frames	3	2	1	1	2	2	1								
		CO3	Carry out various methods on analysis of nonlinear response of structure	2	1	1	1	1	2	1								
		CO4	Apply the solution techniques for nonlinear static analysis of frames and members	2	2	1	1	2	2	1								
		CO5	To perform nonlinear analysis to find the collapse of large structures	3	2	3	1	3	2	1								
CEHO14	Theory of Traffic Flow	CO1	Analyze the traffic stream parameters	3	2	1	1			1			1		1	1	1	1
		CO2	Demonstrate fluid flow modeling	3	1	2	1			1			2		1	1	2	1
		CO3	Apply the queuing theory	3	3	2	1		1	1			3		2	1	2	1
		CO4	Implement car following models	3	2	3	1		1	1			3		1	1	2	1
		CO5	Define the significance of ITS under Indian conditions.	1	1	1	3	2		1	2	3		2	2	3	3	2
CEHO15	Pavement Construction and Maintenance	CO1	Carry out the construction control and quality control checks of subgrade and stabilised layers.	2			1		3	1	1	2		3	3			
		CO2	Carry out the construction of subbase, base and wearing courses in flexible pavements.	2			1		3	1	1	2		3	3			
		CO3	Understand the construction of interlocking block pavements, quality control tests; construction of various types of joints.	2			1		3	1		2		3	3			
		CO4	Understand various distresses and the	1		3	1	1		2	1		2		1			

			evaluation of pavements															
		CO5	Propose suitable maintenance and rehabilitation strategies for pavement failures.	1	3	2	3	3		2	1		2	2	1			
CEHO16	Dynamics of Soils and Foundations	CO1	To interpret the principles of dynamics in Geotechnical Engineering.	3	3	2	2	3	1	2	1	0	1	1	2	3	2	1
		CO2	To predict liquefaction and suggest measures for its mitigation.	2	3	2	2	3	1	2	1	0	1	1	2	2	2	1
		CO3	To reason the response of any soil-structure system.	3	3	3	3	3	2	2	2	0	2	2	3	3	3	2
		CO4	To apply the principles of soil dynamics.	3	3	3	3	3	2	2	2	0	2	2	3	3	3	2
		CO5	To become the proficiency in designing machine foundations and implementing vibration isolation techniques based on dynamic analysis.	3	3	3	3	3	2	2	2	1	2	2	3	3	3	2
CEHO17	Soil Exploration and Field Testing	CO1	To extract samples as per requirement and perform field and laboratory tests.	3	2	3	3	3	2	2	2	1	1	2	2	3	2	2
		CO2	To understand the practical significance of the results obtained from geophysical test methods.	3	3	2	3	3	2	2	2	1	1	2	2	3	2	2
		CO3	To be familiar with Pressure Meter and dilatometer testing and interpretation of test data.	3	3	2	3	3	2	2	2	1	1	2	2	3	2	2
		CO4	To be exposed to measurement of in-situ stresses in rocks and post failure testing of rocks	3	3	2	3	3	2	2	2	1	1	2	2	3	2	2
		CO5	To be exposed to Geotechnical Instrumentation for field monitoring	3	3	3	3	3	3	3	2	2	2	2	3	3	2	2
CEHO18	Physico-Chemical Processes for Water and Wastewater	CO1	Differentiate the physical, chemical and biological characteristics of water and wastewater	1	3	3		3						1	1	2	2	-
		CO2	Evaluate various physical and chemical treatment options for treatment of water	3	3	3	3	3	3	3	3		3	2	1	3	2	3

	Treatment		and wastewater															
		CO3	Explain the mechanism behind the treatment processes and their advantages and disadvantages	3	3	3	3	3						1		3	1	-
		CO4	Design various physico- chemical units for the treatment of water and wastewater	2	2		3	1								2	1	-
		CO5	Analyze and design the advanced treatment systems for the removal of specific constituents	2	3	3	3	3	2	2			2			3	1	2
CEHO19	Biological Treatment of Wastewater	CO1	Describe the range of conventional treatment processes for the treatment of organics	3	3		3	2	3	1					2	2	1	2
		CO2	Execute and assess the performance of bioreactors	3	3	3	3	3								3	1	-
		CO3	Design the biological reactors based on biokinetic parameters	2	2	2	2	2	3	3	2					3	1	2
		CO4	Perform and design the advanced biological treatment processes for the removal of nutrients and micro pollutants	2	3	3	3	3	2	2			2			3	1	2
		CO5	Select appropriate processes for the treatment of specific wastewater, and its design considerations	2	3	3	3	3	2	2			2			3	1	2
CEHO20	Free Surface Flow	CO1	Analyze free surface flows, including velocity, energy, and depth calculations.	3	3	2	2	2	1	1	1	1	2	2	2	2	2	1
		CO2	Evaluate hydraulic jumps and control them with baffle walls and jets.	3	3	3	3	2	2	2	1	1	2	2	3	3	2	1
		CO3	Model flows around boundaries, side weirs, and wastewater structures.	3	3	3	3	2	2	2	1	1	2	2	3	3	3	2
		CO4	Understand flow bulking, air entrainment, and aeration over spillways.	2	2	2	2	2	1	2	1	1	2	2	2	3	2	1
		CO5	Apply St. Venant's equations to dam breaks and flood routing.	3	3	3	3	3	2	2	1	1	3	3	3	3	3	2
CEHO21	Wave	CO1	To understand the basics of wave motion.	2	1	1	1			1			1		3			1

	Hydrodynamics	CO2	To study the different aspects of linear wave theory	3	2	2	2			1	1	1			2		1	1
		CO3	To enhance the knowledge on wave transformation	2	2	1	1		1	1		1			3			1
		CO4	To provide knowledge on various wave theories and wave forces	2	2	1	2		1	1		1		1	3	1		1
		CO5	To analyze non-breaking wave using different wave structure Interaction Methods	3	3	2	3		1			1		1	3	1	1	1
CEHO22	Advanced Remote Sensing Techniques	CO1	Acquire knowledge on the various Understand the satellite data products for various civil engineering applications.	3	3		1	3				2	2	2	1	1	3	2
		CO2	Get a sound knowledge on the various remote sensing data products for mapping and modelling of susceptibility and vulnerability.	3	3		1	3				2	2	2	1	1	3	2
		CO3	Acquire knowledge about soft computing techniques, advanced GIS and remote sensing tools.	3	3		1	3				2	2	2	1	1	3	2
		CO4	Execute and evaluate the real-time problems using advanced geospatial techniques.	3	3		1	3				2	2	2	1	1	3	2
		CO5	Gain knowledge to develop the technical and technological measures for vulnerability and susceptibility modelling.	3	3		1	3				2	2	2	1	1	3	2
CEHO23	River Hydraulics and Sediment Transport	CO1	Know the fundamental of free surface flow and sediment transport in rivers and channels.	2	2	3	1	1	1	1			1	1	2		1	1
		CO2	Compute the flow velocity distribution, roughness in a channel with given geometry, plan form and flow conditions.	3	2	3	2	2	1	2		1		1	2	1	1	1
		CO3	Able to understand the characteristic of nonuniform flow and unsteady flow in a	3	3	1	1	2	1	1				1	2		1	1

			Channel.															
		CO4	Able to solve the problem of propagation of flood wave, flood routing and surges in channels.	3	3	3	2	3	1	2			1	1	2	1	2	1
		CO5	Understand the hydraulics of sediment transport in mobile bed channel.	3	2	2	1	2		1		1	1		1		1	1
CEHO24	Advanced Soil Mechanics	CO1	Understand the physio-chemical behavior of soils, including diffused double layer theory, soil-water interactions, and swelling and shrinkage behaviour	3	2	1	2	1	1	2	1	1	1	1	1	3	1	2
		CO2	Comprehend soil fabric, compaction, and the concept of effective stress, and apply theories of stress distribution in soil.	3	3	2	2	2	1	2	1	1	1	1	1	3	2	1
		CO3	Evaluate shear resistance in soils, including stress-strain relationships, failure criteria, and pore pressure in saturated and unsaturated soils.	3	3	2	2	2	1	2	1	1	1	1	1	3	2	1
		CO4	Understand the mechanics of soil consolidation and apply Terzaghi's theory to estimate settlements and determine precompression history.	3	3	2	2	2	1	2	1	1	1	1	1	3	1	2
		CO5	Analyze flow through soils, including unidimensional, radial, and spherical flow, and understand the concepts of quicksand, piping, and flow nets.	3	3	2	2	2	1	2	1	1	1	1	1	3	2	1
CEHO25	Soft Computing Techniques in Civil Engineering	CO1	Understand and appreciate the basics concepts related to soft computing techniques and the need for soft computing techniques	2	1	2	2	2	2	1	1	2	2	3	2	2	2	1
		CO2	Learn and apply concepts related to genetic algorithms in the context of construction project management	2	2	2	2	2	1	1	1	2	2	3	2	2	3	1
		CO3	Comprehend and apply concepts related	2	2	2	3	2	1	1	1	2	2	3	3	2	2	1

			to fuzzy logic and its application in the context of construction project management															
		CO4	Assess and apply concepts related to artificial neural networks in the context of construction project management	3	1	3	3	2	2	2	1	3	2	3	3	2	3	1
		CO5	Examine and apply concepts related to hybrid systems in the context of construction project management	1	1	2	2	1	2	1	1	2	1	2	3	2	3	1
CEHO26	Quantitative Methods in Construction Management	CO1	Demonstrate the application of operations research techniques to enhance managerial decision-making in construction projects	3	3	2	2	3	2	2	2	2	1	2	2	2	3	2
		CO2	Utilize various optimization techniques in engineering planning, design, and construction contexts	3	3	3	3	3	2	2	2	1	2	2	2	2	2	2
		CO3	Formulate and solve linear optimization models	2	2	2	2	2	2	2	1	1	1	2	1	1	1	1
		CO4	Apply approximation methods to solve transportation problems in construction projects	2	1	1	1	3	1	1	1	2	2	2	2	2	2	2
		CO5	Utilize decision theory, queuing theory, games theory, and Monte Carlo simulation to analyze and solve complex construction management problems	1	2	2	1	2	2	2	1	2	3	2	2	1	3	2

3 - High; 2 - Medium; 1 - Low

GENERAL INSTITUTE REQUIREMENT (GIR)

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

3 - High; 2 - Medium; 1 - Low

Course Code	Course Title	CO	Course outcomes At the end of the course student will be able	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CEIR15	Introduction to Civil Engineering	CO1	Apply principles of analysis and design to various structural systems in buildings, bridges, and infrastructure projects.	2	1	1	1	0	3	3	3	2	2	1	1	3	1	3
		CO2	Apply principles of analysis and design to various structural systems in buildings, bridges, and infrastructure projects.	3	3	3	2	2	2	2	2	1	2	1	1	2	2	2
		CO3	Evaluate transportation systems, design pavements using conventional and new materials, and understand airfield pavement structure.	2	1	2	1	2	2	2	1	1	1	1	1	2	2	2
		CO4	Design infrastructure for water and wastewater management in civil engineering projects.	3	2	2	2	1	3	3	1	1	2	2	1	2	2	3
		CO5	Utilize surveying methods, maps, aerial photographs, GPS, LiDAR, UAV surveys, and GIS in civil engineering projects effectively.	2	1	2	1	2	2	2	1	1	1	1	1	2	2	2
CEIR11	Basics of Civil Engineering	CO1	Gain knowledge on site selection, construction materials, components of buildings, roads and water resources	3	2	2	1	1	3	3	2	1	2	2	2	2	1	3
		CO2	Appreciate multidisciplinary approach	3	2	3	2	2	2	2	2	1	2	1	1	2	2	2

			when involved in Civil Related Projects.															
		CO3	Comprehend the classification of rural and urban roads, pavement materials, and traffic management.	3	2	3	2	2	2	2	1	2	2	2	2	2	2	2
		CO4	Demonstrate proficiency in surveying techniques and equipment.	3	3	3	2	2	3	2	1	1	2	2	1	3	2	2
		CO5	Understand various sources of water, water supply systems, quality assessment, wastewater treatment, and groundwater management.	3	2	2	2	2	3	3	1	1	1	2	1	3	2	2
CEIR14	Professional Ethics	CO1	Understand the core values that shape the ethical behaviour of an engineer	2	2	2			3	3	3			3		2	2	3
		CO2	Apply ethical principles pertaining to their engineering society	2	2	2			2	2	3			3		2	2	3
		CO3	Comprehend and assess the rights of self and others in the context of practicing an engineering field	1	1	1			3	2	3			3		2	2	3
		CO4	Assess and appreciate the importance of professional ethics from a global management perspective	2	2	2			3	3	3	2	2	3	1	2	2	3
		CO5	Perform their role in technological development from an ethical perspective	2	2	2	1	1	3	3	3	2	2	3	1	2	2	3
CEIR16	Winter Internship	CO1	Apply theoretical Civil Engineering knowledge to practical projects and real-world situations.	3	2	3	2	2							3			3
		CO2	Develop and execute project plans in a professional environment.	2	3	3	2	2		1		2	2		3	1	3	
		CO3	Communicate effectively with project teams, clients, and stakeholders through reports and presentations.	1	2	2		2		1		3	3	2		2		2
		CO4	Demonstrate professional ethics, responsibility, and conduct in a Civil		2	2		2	1		1	3	3	1		2		2

			Engineering setting.															
		CO5	Analyze and reflect on internship experiences to identify areas for personal and professional growth	2		1	2		3	2	3		1	2		3	1	3
CEIR16	Summer Internship	CO1	Apply theoretical Civil Engineering knowledge to practical projects and real-world situations.	3	2	3	2	2							3			3
		CO2	Develop and execute project plans in a professional environment.	2	3	3	2	2		1		2	2		3	1	3	
		CO3	Communicate effectively with project teams, clients, and stakeholders through reports and presentations.	1	2	2		2		1		3	3	2		2		2
		CO4	Demonstrate professional ethics, responsibility, and conduct in a Civil Engineering setting.		2	2		2	1		1	3	3	1		2		2
		CO5	Analyze and reflect on internship experiences to identify areas for personal and professional growth	2		1	2		3	2	3		1	2		3	1	3
CEIR19	Industrial Lecture	CO1	Understand and discuss current industry trends and practices in Civil Engineering.	3	2	2		2		2		1			3	2		3
		CO2	Apply theoretical knowledge to analyze industrial case studies and practices.	2	3	3	2	2	1			2	1			2	3	
		CO3	Demonstrate understanding of professional ethics and responsibilities in the Civil Engineering industry.			2			1	2	3		2		1			2
		CO4	Engage with industry professionals to enhance problem-solving and critical thinking skills.	2	2						2	3			2	2		
		CO5	Reflect on the importance of continuous learning and professional development in Civil Engineering	2					2				1	2	3			3

CEIR17	Project Work	CO1	Identify and define a complex Civil Engineering problem through detailed literature review and research.	3	3		2			1	1		1			3		3
		CO2	Apply Civil Engineering principles and modern tools to develop and execute a project plan.	3	3	3	3		1		1		2		3	3		
		CO3	Design and implement innovative solutions to address specific Civil Engineering challenges.	1		3	3	3		1	1		2		3		3	3
		CO4	Communicate project outcomes effectively through well-structured reports and presentations.	2	1	3	3	3			1	1		2	3		3	3
		CO5	Demonstrate teamwork, ethical responsibility, and project management skills in executing the project.	2		1	2	1		3	3		3	3	2			1
CEIR18	Comprehensive Viva Voce	CO1	Analyze statically determinate and indeterminate structures using structural analysis methods.	3	3	2	2	2	1	1	1	2	1	2	1	2	2	1
		CO2	Design concrete and steel structural components based on design codes and standards.	3	3	3	2	3	2	2	1	2	2	2	1	3	3	2
		CO3	Evaluate soil properties and design foundation systems for various soil conditions.	2	2	3	1	2	1	2	1	1	1	2	1	2	2	2
		CO4	Apply fluid mechanics and hydrology principles to design water resource systems.	2	2	2	2	2	1	2	1	1	1	2	1	2	2	1
		CO5	Implement environmental engineering practices for water and wastewater treatment and solid waste management.	2	1	2	2	1	1	1	2	1	1	2	1	2	1	3

3 - High; 2 - Medium; 1 - Low

PROGRAMME CORE (PC)

CEPC10 ENGINEERING MECHANICS

Course Code	**:**	CEPC10
Course Title	**:**	**Engineering Mechanics**
Type of Course	**:**	PC
Prerequisites	**:**	-
Contact Hours	**:**	46
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To explain the importance of mechanics in the context of engineering and conservation equations
CLO2	To explain the significance of centroid, center of gravity and moment of inertia
CLO3	To introduce the techniques for analyzing the forces in the bodies
CLO4	To analyze the internal member forces acting on cables and trusses
CLO5	To understand the basic principles of dynamics

Course Content

Fundamentals: Mechanics and its relevance, concepts of forces, laws of mechanics – Lami's Theorem, Concept of free-body diagram, centroids, center of gravity, area moment of inertia, mass, moment of inertia.

Friction: Laws of friction, application of laws of friction, wedge friction, body on inclined planes.

Statics: Principles of statics, Types of forces, concurrent and non-concurrent forces, composition of forces, forces in a plane and space, stresses and strains, elastic constant.

Beams, Cables and Trusses: Beams subjected to concentrated loads, UDL with supports at different levels- analysis of Trusses – method of joints – method of sections.

Dynamics: Principles of dynamics, D'Alembert's principle, conservation of momentum and energy, vibrations of simple systems.

References

1	Kumar K.L., Kumar V, 'Engineering Mechanics', Tata McGraw Hill, 2011.
2	Rajasekaran S and Sankarasubramanian G, 'Engineering Mechanics Statics and Dynamics', Third Edition, Vikas Publishing House Pvt.Ltd, 2005.
3	Timoshenko S, and Young D.H, 'Engineering Mechanics', Tata McGraw Hill, 2006.
4	Popov E.P, 'Engineering Mechanics of Solids', Prentice Hall, 1998.
5	Shames I.H, and Rao G.K.M, 'Engineering Mechanics – Static and Dynamics', Pearson Education, 2009.

6	Beer F.P and Johnson Jr.E.R, 'Vector Mechanics for Engineers', Tata McGraw Hill, 2009.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Estimate the system of forces, free-body diagrams, law of mechanics, Lami's theorem
CO2	Arrive sectional properties such as centroid, centre of gravity, area moment of Inertia, mass moment of inertia
CO3	Estimate the Frictional forces, laws of friction at different planes
CO4	Analyse simple stresses, strains and elastic constants
CO5	Better understanding of trusses by method of joints, principles of dynamics, vibration of simple systems

CEPC11 CONCRETE TECHNOLOGY AND CONSTRUCTION MANAGEMENT

Course Code	**:**	CEPC11
Course Title	**:**	**Concrete Technology and Construction Management**
Type of Course	**:**	PC
Prerequisites	**:**	-
Contact Hours	**:**	46
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	Assess and test the fresh, mechanical, and durability properties of concrete using standard and non-destructive methods.
CLO2	Develop and optimize concrete mix designs to meet specific performance criteria and quality standards.
CLO3	Perform the role of a construction/project manager efficiently with precise knowledge of the roles and responsibilities
CLO4	Analyse and estimate the resources required for a construction project
CLO5	Comprehend and apply project planning and scheduling tools to estimate the time and cost of a construction project

Course Content

Constituents of concrete: Cement, aggregates, chemical and mineral admixtures: types, tests, and their physical, chemical, and microstructural properties

Process of Concrete Manufacturing; Mix design- roles of water to cement ratio, water content, admixtures, particle packing: IS method, ACI method. Properties of concrete: Fresh, mechanical, and durability properties along with corresponding tests including NDT

Constituents of concrete: Cement, aggregates, chemical and mineral admixtures: types,

tests, and their physical, chemical, and microstructural properties; Process of Concrete Manufacturing.

Mix design- roles of water to cement ratio, water content, admixtures, particle packing: IS method, ACI method; Properties of concrete: Fresh, mechanical, and durability properties along with corresponding tests including NDT

Introduction to Construction Projects and Construction Project Management, Construction Project Lifecycle and its Phases, Project Formation, Management Objectives and Functions, Organisational Chart of a Construction Organisation and Project, Construction/Project Manager's Duties and Responsibilities, Role of Key Project Stakeholders and Public Relations

References

1.	Mehta, P. K., & Monteiro, P. (2017). Concrete: microstructure, properties, and materials. Fourth Edition, Tata McGraw Hill
2.	Shetty, M. S., & Jain, A. K. (2019). Concrete Technology (Theory and Practice), 8e. S. Chand Publishing.
3.	Gambhir, M. L. (2017). *Concrete technology: theory and practice (5th edition)*. Tata McGraw-Hill Education.
4.	Santakumar, A.R. (2018). Concrete Technology (2nd edition), Oxford University Press,
5.	IS 456 (2000), Plain and Reinforced Concrete - Code of Practice, Bureau of Indian Standards (BIS), New Delhi, India.
6.	IS 10262 (2019), Concrete Mix Proportioning – Guidelines, Bureau of Indian Standards (BIS), New Delhi, India.
7.	ACI-318-19(22) Building code requirements for structural concrete (ACI 318-2022) and Commentary (ACI 318R-2014). American Concrete Institute, Detroit, MI, USA.
8.	Oberlender, G. D., & Oberlender, G. D. (2014). Project management for engineering and construction. New York: McGraw-Hill.
9.	Sawhney, A., Riley, M., & Irizarry, J. (Eds.). (2020). Construction 4.0: An Innovation Platform for the Built Environment. Routledge.
10.	Walker, A. (2015). Project management in construction. John Wiley & Sons.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Assess and test the fresh, mechanical, and durability properties of concrete using standard and non-destructive methods.
CO2	Develop and optimize concrete mix designs to meet specific performance criteria and quality standards.
CO3	Perform the role of a construction/project manager efficiently with precise knowledge of the roles and responsibilities
CO4	Analyse and estimate the resources required for a construction project
CO5	Comprehend and apply project planning and scheduling tools to estimate the time and cost of a construction project

CEPC12 HYDRAULICS AND FLUID MACHINERY

Course Code	**:**	CEPC12
Course Title	**:**	**Hydraulics and Fluid Machinery**
Type of Course	**:**	PC
Prerequisites	**:**	-
Contact Hours	**:**	46
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the properties of fluids and fluid statics.
CLO2	To solve kinematic problems such as finding particle paths and stream lines.
CLO3	To use important concepts of continuity equation, Bernoulli's equation and turbulence, and apply the same to problems.
CLO4	To study about specific speed and performance characteristics of different types of turbines.
CLO5	To study types of centrifugal Pumps, work done and efficiency of the different types centrifugal pumps and also study about performance of pumps & characteristic curves.

Course Content

Continuum concept - CGS, MKS and SI systems - Properties of Fluids - Ideal and real fluid - Flow classification, stream lines, streak lines, continuity equation, velocity, tangential, normal, local and convective acceleration, types of fluid motions, stream function, velocity potential function, flownet.

Pressure at a point – pascal law - Hydrostatic law - pressure measurement – Hydrostatic forces on immersed plane and curved surfaces, Buoyancy, Stability of floating and submerged bodies. Bernoulli's equation, Energy correction factor, Coefficients of contraction, velocity and discharge, free vortex motion, Analysis of free liquid Jet, Cavitation.

Laminar and turbulent flow - Reynold's number - Navier stoke equations of motion - shear stress and pressure gradient - Laminar flow between parallel plates - Couette flow - Hagen Poiseuille equation for flow through circular pipes.

Turbulence - Major losses - Darcy-Weisbach equation for flow through circular pipe - Friction factor - Smooth and rough pipes - Moody diagram - Minor losses - pipes in series and parallel - Equivalent length - water hammer phenomena- flow measurement – orifice mouth piece, weirs, flow under sluice gates.

Centrifugal pump - minimum speed to start the pump – multistage Pumps –Positive displacement pumps – reciprocating pump - negative slip - flow separation conditions - air vessels -indicator diagram and its variation - savings in work done- Turbines - draft tube and cavitations –classification - radial flow turbines - axial flow turbines – Impulse and Reaction turbines.

References

1	Nagaratnam, S., Fluid Mechanics, Khanna Publishers, 1995.
2	Natarajan, M.K. Principles of Fluid Mechanics, Oxford & IBH Publishing Co, 1994.
3	JagdishLal, Hydraulics and Fluid Mechanics, Tata McGraw Hill, 2001.
4	Streeter V.L., Fluid mechanics, Tata McGraw Hill, 1998.
5	S K Som, Gautam Biswas & S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, 3rd Edition, McGraw Hill Education, 2017

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Understand the basic principles of fluid mechanics.
CO2	Understand the concepts of statics and dynamics of fluid flow.
CO3	Develops skills in analyzing fluid flows through the proper use of modeling and the application of the basic fluid-flow principles.
CO4	Acquire knowledge in the selection of type of turbine required with reference to available head of water and also used for Identification of type of turbine with estimated specific speed.
CO5	Capable of estimating efficiency of different pumps and performance of the pumps with the study of characteristics curves.

CEPC13 SURVEYING

Course Code	**:**	CEPC13
Course Title	**:**	**Surveying**
Type of Course	**:**	PC
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the importance of surveying in the field of civil engineering
CLO2	To get introduced to different plane and geodetic surveying applications such as chain, compass, plane table, leveling, triangulation, trigonometric leveling etc
CLO3	To understand the significance of each method in civil engineering and master the skill to carry out the proper surveying method in the field
CLO4	To design numerical solutions for carrying out surveying in civil engineering field.
CLO5	To get introduced to modern advanced surveying techniques involved such as Remote sensing, Total station, GPS etc.

Course Content

Introduction and Principles of surveying - Classification - Brief introduction to chain surveying - Compass surveying - Bearing of survey lines - systems and conversions - Local attraction - Latitude and departure - Traverse adjustment of closing errors

Plane Table surveying - instruments and accessories - methods of plane tabling - Levelling - Levelling instruments - Temporary and permanent adjustments - Booking - Reduction to levels

Theodolite surveying - Vernier theodolite - Temporary and permanent adjustments - Measurement of horizontal and vertical angles - Tacheometric surveying - Stadia system - Fixed and Movable hair methods - Subtense bar - Tangential method

Introduction to Triangulation - Trignometrical levelling - Observations for heights and distances

Application of surveying - Types - Introduction to Advanced Surveying Techniques - EDM - Total station - Remote Sensing - GPS - GIS - Drones

References

1	Duggal, S.K. Surveying Vol. I and II, Tata McGraw Hill, 2019.
2	Punmia, B.C. Surveying Vol.I and II, Laxmi Publications, 2016 (Vol I), 2023 (Vol II).
3	Punmia, B.C. Higher Surveying Vol III, Laxmi Publications, 2022.
4	Arora, K. R. Surveying Vol. I and II, Standard Book House, 2019.
5	Satheesh Gopi. Advanced Surveying, Pearson Education, 2017.
6	Satheesh Gopi. The Global Positioning System, Tata McGraw, 2017.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Knowledge of the importance of preliminary surveying such as chain surveying, compass surveying and error adjustment in the field of civil engineering applications such as structural, high way engineering, geotechnical engineering
CO2	Ability to plan a survey, taking accurate measurements, field booking, plotting and adjustment of traverse can be understood through leveling, plane table surveying etc
CO3	Understanding of fundamental function, use of Theodolite and tacheometry in practical applications such as road alignment, height of building, control point setting etc, g with respect to utility and precision through the use of Theodolite, tacheometry
CO4	Ability to understand the concepts of Trignometrical Levelling, Triangulation in surveying
CO5	Understanding the importance of advanced surveying measurement techniques in civil engineering applications.

CEPC14 MECHANICS OF SOLIDS

Course Code	**:**	CEPC14
Course Title	**:**	**Mechanics of Solids**
Type of Course	**:**	PC
Prerequisites	**:**	CEPC10
Contact Hours	**:**	36

Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn about the concept of stress, strain and deformation of solids
CLO2	To know the concepts of virtual work, strain energy and principal stress
CLO3	To learn the bending moment, shear force and the corresponding stress distribution for different types of beams
CLO4	To study the different methods of finding deflection of beams and trusses and understand the torsion behaviour of solid and hollow circular shafts
CLO5	To analyse columns of varying end support conditions by Euler Theory and Rankine's formula

Course Content

Simple, compound and thermal stresses - composite bars – strain energy and resilience - Principal stress and principal planes Mohr's circles

Shear force and bending moment for different determinate beams – Euler Bernoulli beam theory - Stress distribution at a cross section due to Bending Moment and Shear

Deflection of beams using double integration and semi graphical methods such as conjugate beam and moment area method- Principle of virtual displacement and virtual forces - Castigliano's first theorem - Maxwell's reciprocal theorem.

Strain energy and dummy unit load approaches to deflection of trusses - Theory of torsion - Torsion of circular and hollow circular shafts and shear stresses due to torsion

Theory of columns: Axial load- Euler's theory-Rankines formula, combined bending and axial load

References

1.	Hibbeler, R.C., Mechanics of Materials, Pearson, 2016
2.	Ramamrutham, S., Strength of Materials, Dhanpat Rai Publishing Co Pvt Ltd., 2011
3.	Timoshenko, S.P. and Gere, J.M. Mechanics of Materials, Tata McGraw Hill, 1992
4.	Rajput R.K., Strength of Materials, S. Chand & Co., Ltd., 1996.
5.	R K Bansal., Strength of Materials, Laxmi Publications, 2009

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Determine the strength parameters of the materials and solve principal stress and principal plane problems
CO2	Determine shear force, bending moment, bending and shear stress distribution
CO3	Determine deflection of a beam for various loading conditions and also trusses
CO4	Analyze members subjected to torsion
CO5	Visualize the behavior of column for combined bending and axial loading

CEPC15 ANALYSIS OF INDETERMINATE STRUCTURES

Course Code	**:**	CEPC15
Course Title	**:**	**Analysis Of Indeterminate Structures**
Type of Course	**:**	PC
Prerequisites	**:**	CEPC14
Contact Hours	**:**	46
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn the concepts of indeterminacy and methods for calculating bending moment and shear force on basic indeterminate beams
CLO2	To understand the concept of analysis of indeterminate structures by various classical methods
CLO3	To study the use of ILD for determinate structure
CLO4	To learn the concepts of moving loads and its effect on structures
CLO5	To understand the approximate methods for analysis multistorey plane frames

Course Content

Propped cantilevers, Continuous and Fixed Beams – Clapeyron's 3 moment theorem- Bending moment and shear force diagrams – static and kinematic indeterminacy

Slope deflection method - analysis of indeterminate structures- Settlement- Moment distribution method - analysis of frames - settlement of supports - sway. Energy methods - Kani's method - analysis of indeterminate structures - settlement of supports - sway.

Moving loads -single load - two point loads - several points loads - maximum bending moment and maximum shear force - equivalent u.d.l. - absolute maximum bending moment.

Enveloping curves for maximum bending moment and maximum shear force and determination of equivalent UDL, ILD for shear, moment and reactions for beams and trusses - Reversal of stresses under live load.

Analysis of multistorey frames for gravity and lateral loads by approximate methods - Portal and Cantilever methods

References

1	Hibbeler, R.C., Structural Analysis, Pearson, 2017
2	Vaidyanathan, R., and Perumal, P., Structural Analysis Vol I, Laxmi Publications, 2016.
3	Menon, D., Structural Analysis, Narosa Publishing House, 2008
4	Jindal. R.L, Indeterminate Structures, Chan Tea, New Delhi, 2000
5	Punmia B.C., Theory of Structures, Standard Book House, New Delhi, 2000

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Analyse the basic indeterminate beams such as Propped cantilevers, Continuous and Fixed Beams
CO2	Use various classical methods for analysis of indeterminate structures
CO3	Determine the effect of support settlements for indeterminate structures
CO4	Apply the concepts of ILD and moving loads on determinate structures
CO5	Apply approximate methods to analyse multistorey plane frames

CEPC16 SOIL MECHANICS

Course Code	**:**	CEPC16
Course Title	**:**	**Soil Mechanics**
Type of Course	**:**	PC
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To identify and classify soils based on their structure and properties, and understand their relevance in civil engineering.
CLO2	To determine the coefficient of permeability in the laboratory and construct flow nets for analyzing steady-state seepage flow.
CLO3	To use Boussinesq and Westergaard's equations and Newmark's influence chart to analyze vertical stress distribution in soils.
CLO4	To conduct shear strength tests and use Mohr's circle to evaluate shear properties of cohesionless and cohesive soils.
CLO5	To apply Terzaghi's consolidation theory to determine total settlement, time rate of settlement, and preconsolidation pressure of soils.

Course Content

Preview of Geotechnical Problems in Civil Engineering and Infrastructure, Development, Historical development of Soil Engineering - Origin and general types of soils – soil structure, clay minerals-Three phase system- Identification and Classification of soils.

Soil water - capillary phenomena - concept of effective and neutral stresses – Permeability - determination of coefficient of permeability in the laboratory - Seepage flow - Head, gradient, pressure - steady state flow - two dimensional - flow net.

Vertical stress distribution in soil - Boussinesq and Westergaard's equation - Newmark's influence chart - principle, construction and use - Equivalent point load and other approximate methods - pressure bulb - Compaction.

Shear strength - Mohr-Coulomb failure criterion - shear strength tests – Different drainage conditions - Shear properties of cohesionless and cohesive soils - Use of Mohr's circle - relationship between principal stresses and shear parameters.

Compressibility and consolidation - Terzaghi's one dimensional consolidation theory pressure void ratio relationship - preconsolidation pressure - Total settlement and time rate of settlement - coefficient of consolidation - curve fitting methods - Correction for construction time

References

1	Gopal Ranjan Rao, P. Basic and Applied Soil Mechanics, New Age International Pvt. Limited, New Delhi, 2002.
2	Murthy, V.N.S., A text book of Soil Mechanics and Foundation Engineering, UBS Publishers Distributors Ltd., New Delhi, 1999
3	Punmia, B.C. Soil Mechanics and Foundation Engineering, Laxmi Publications Pvt. Ltd., New Delhi, 1995.
4	Braja M. Das, Fundamentals of Geotechnical Engineering, Thomson Asia Pvt. Ltd.,Singapore, 2005.
5	Braja M. Das, Principles of Geotechnical Engineering, Thomson Asia Pvt. Ltd., Singapore, 2008.
6	Robert D. Holtz, William D. Kovacs and Thomas C. Sheahan, An Introduction to Geotechnical Engineering, Pearson, 2013.
7	Donald P. Coduto, Man-Chu Ronald Yeung and William A. Kitch, Geotechnical Engineering, Principles and Practices, PHI Learning Private limited, 2011.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Understand the historical development of soil engineering and classify soils based on their origin, structure, and properties.
CO2	Analyze soil-water interactions, determine permeability, and construct flow nets for two-dimensional seepage flow.
CO3	Calculate vertical stress distribution in soils using Boussinesq and Westergaard's equations and utilize Newmark's influence chart.
CO4	Evaluate shear strength parameters of soils under different drainage conditions using Mohr-Coulomb failure criterion and shear strength tests.
CO5	Apply Terzaghi's one-dimensional consolidation theory to determine settlement characteristics and consolidation parameters of soils.

CEPC17 WATER SUPPLY ENGINEERING

Course Code	**:**	CEPC17
Course Title	**:**	**Water Supply Engineering**
Type of Course	**:**	PC
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To make the students conversant with sources of water and its demand
CLO2	To understand the basic characteristics of water and its determination
CLO3	To expose the students to understand components of water supply lines
CLO4	To provide adequate knowledge about the water treatment processes and its design
CLO5	To learn water distribution network and water supply to buildings

Course Content

Physical, chemical and biological characteristics of water – Water analysis – IS and WHO standards – Requirements of water supply – Types of demand and their contribution – Rate of consumption – Population Forecasting – Variation in demand pattern;

Sources of water – Quantitative and qualitative studies; Intakes – Channels and pipes for conveying water – Pipes – Hydraulic design of pressure pipe – Materials – Laying – Joining – Testing – Pipe appurtenances – Pumps and pumping stations;

Treatment plants – Process of treatments – Mixing – Aeration – Sedimentation – Coagulation – Filtration – Disinfection - Softening – Advanced water treatment;

Distribution systems – Analysis of distribution networks - Operation and maintenance of water supply to buildings – Rural water supply – Protected water supply –Saline water intrusion

References

1	Manual on Water supply and Treatment – CPHEEO, 1999.
2	Peavy H. S., Rowe D. R. and Tchobanoglous G., Environmental Engineering, McGraw Hill, New York, 1985.
3	Davis M. L. and Cornwell D. A., Introduction to Environmental Engineering, Tata McGraw Hill Education Pvt. Ltd,. New Delhi, 2010.
4	Birdie, G. S. and Birdie, Water Supply and Sanitary Engineering, Dhanpat Rai & Sons, 2014.
5	Duggal, K. N., Elements of Environmental Engineering, S. Chand & Co., 2008.
6	Punmia B. C., Ashok Jain & Arun Jain, Water Supply Engineering, Laxmi Publication Pvt., Ltd., New Delhi, 2005.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	estimate various water quality parameters
CO2	forecast the population and estimate the water demand
CO3	differentiate various intake structures and select suitable pipe material for water conveyance
CO4	design various water treatment units
CO5	analyse water distribution networks

CEPC18 DESIGN OF REINFORCED CONCRETE STRUCTURAL ELEMENTS

Course Code	**:**	CEPC18
Course Title	**:**	**Design of Reinforced Concrete Structural Elements**
Type of Course	**:**	PC
Prerequisites	**:**	CEPC15
Contact Hours	**:**	46
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To study the stress strain behavior of steel and concrete
CLO2	To understand the concept of working stress and limit state methods
CLO3	To gain the knowledge of limit state design for flexure, shear, torsion, bond and anchorage
CLO4	To understand the behavior of columns subjected to eccentric load and use of interaction diagrams
CLO5	To study the design of various foundation

Course Content

Stress-strain behavior of steel and concrete- Introduction to working stress method (WSM) - permissible stresses. Ultimate load method (ULM) - Limit state method-Probabilistic Analysis and Design - Characteristic strength and load - Partial safety factor – Codal recommendations

Behavior in flexure –Modular ratio and cracking moment, Transformed sections, Analysis at WSM and ULM - Design of singly and doubly reinforced beams, T and L beams – Serviceability Limit States: Deflection and Cracking

Design of Slabs - one-way and two-way slabs for different edge conditions - Yield line theory - Flat slabs - Stair cases - different types.

Design for Shear – behaviour of reinforced concrete under shear – design shear strength with and without shear reinforcement. Design for Torsion - general behaviour in torsion - design strength in torsion. Design for Bond – bond failure and strength – splicing of reinforcement – codal recommendations

Design of compression members - Columns - axially loaded and eccentrically loaded columns Interaction diagrams - biaxial bending and slender columns– effective length

Footings - isolated footings - square, rectangular and circular footings - Combined footing - the design, detailing and drawings of various R.C.C structural elements

References

1	Krishna Raju, N., Reinforced Concrete Design: IS:456-2000 Principles and Practice, New Age International Publishers, 2018

2	Pillai, S. U. and Menon, D. Reinforced Concrete Design. McGraw Hill Education Private Limited, New Delhi, India, 3rd edition, 2009
3	Park, R., and Paulay, T., Reinforced Concrete Structures, John Wiley & Sons, 1975
4	Varghese, Limit state design of concrete, Oxford IBH, 2000.
5	McCORMAC J.C. and Brown R. H., Design of Reinforced Concrete, John Wiley & Sons Inc, USA, 8th edition, 2010
6	IS456-2000 Code of practice for Plain and reinforced concrete code of practice.
7	ACI 318 (2014), Building code requirements for structural concrete (ACI 318-

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Apply the fundamental concepts of working stress method and limit state method
CO2	Use IS code of practice for the design of concrete elements
CO3	Design the beams, slab, stairs, column and footing
CO4	Draw various RCC structural elements
CO5	Detail various RCC structural elements

CEPC19 HIGHWAY AND PAVEMENT ENGINEERING

Course Code	**:**	CEPC19
Course Title	**:**	**Highway and Pavement Engineering**
Type of Course	**:**	PC
Prerequisites	**:**	-
Contact Hours	**:**	46
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the importance of transportation, characteristics of road transport, highway planning, alignment and surveys
CLO2	To know the geometric design of highways
CLO3	To study traffic characteristics and principles of intersection design
CLO4	To know about pavement materials and design
CLO5	To understand pavement construction, distresses in pavements and maintenance options

Course Content

Highway Planning: Different modes of transportation, Characteristics of Road Transportation, Highway Development in India, Classification of Roads, Network patterns. Principles of highway alignment – requirements and controlling factors. Engineering surveys for alignment - conventional and modern methods. Typical cross sections of Urban and Rural roads - cross sectional elements.

Highway Geometric Design: Factors affecting geometric design. Sight distance - stopping

sight distance, overtaking sight distance, sight distance at intersections.

Design of horizontal alignment - super elevation, widening of pavements, transition curves. Design of vertical alignment - gradients, summit and valley curves.

Traffic Engineering: Road user, vehicle and highway characteristics – Principles of traffic studies. Concept of PCU, Traffic capacity and Level of service. Traffic signs and road markings - objectives, classification and uses. Principles of design of at- grade intersections – channelized, rotary and signalized intersections. Introduction to grade separated interchanges.

Pavement Materials and Design: Desirable properties of subgrade soil, road aggregates and bituminous materials - Pavement components and their functions - Factors influencing the design of pavements - Design of flexible and rigid pavements as per IRC.

Pavement Construction and Maintenance: Construction of gravel, WBM, bituminous and cement concrete roads. Pavement failures - Types and causes of failures in flexible and rigid pavements. Maintenance of highway pavements. Strengthening of existing pavements - evaluation, overlay design. Recycling of pavements.

References

1	Khanna, S. K., Justo, C. E. G. and Veeraragavan A., Highway Engineering, Nem Chand and Bros, Roorkee, 2014.
2	Kadiyali, L.R, Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, 2011.
3	Kadiyali, L.R, and Lal, N.B. Principles and Practice of Highway Engineering, Khanna Publishers.2005.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Carry out surveys involved in planning and highway alignment
CO2	Design cross section elements, sight distance, horizontal and vertical alignment
CO3	Implement traffic studies, traffic regulations and control, and intersection design
CO4	Determine the characteristics of pavement materials and design of pavements
CO5	Understand construction and maintenance of pavements

CEPC20 FOUNDATION ENGINEERING

Course Code	**:**	CEPC20
Course Title	**:**	**Foundation Engineering**
Type of Course	**:**	PC
Prerequisites	**:**	CEPC16
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To conduct soil exploration using methods like augur boring, plate load tests, and geophysical explorations to obtain soil properties.
CLO2	To use plastic equilibrium concepts and graphical solutions to determine earth pressures in cohesive and cohesionless soils.
CLO3	To apply Prandtl's and Terzaghi's bearing capacity theories to design foundations and ensure they meet building code requirements.
CLO4	To perform settlement analysis and design various types of shallow foundations, ensuring appropriate contact pressure distribution.
CLO5	To determine the load-carrying capacity of piles using static and dynamic formulas, and analyze settlement and efficiency of pile groups.

Course Content

Soil exploration - Planning - Augur boring - Soundings - Sampling - Plate load test, static and dynamic penetrations tests - geophysical explorations

Lateral Earth Pressure – Plastic equilibrium - Rankine's theory - Active and passive earth pressure for cohesionless and cohesive soils - Earth pressure at rest - Coloumb's wedge theory - Rebhann's and Culmann's graphical solutions, Stability analysis

Foundation - functions and requisites- Different types - choice of foundation type – general principles of design. Bearing capacity - types of failures - Prandtl's and Terzaghi's bearing capacity analysis - Bearing capacity based on settlement and building codes

Shallow foundation - spread footings - combined footings - trapezoidal and strap footings - Raft foundation - Contact pressure distribution - settlement analysis - Types of settlement, Control

Deep foundation - piles - types - load carrying capacity of pile - static and dynamic formula - pile load test - penetration test - pile groups - Efficiency - Feld's rule – Converse Labarre formula, Settlement of piles and pile groups - Negative skin friction – under-reamed piles

References

1.	Murthy, V.N.S, A text book of Soil Mechanics and Foundation Engineering, UBS Publishers & Distributors Pvt. Ltd., New Delhi 1999.
2.	Punmia, B.C. Soil Mechanics and Foundation Engineering, Laxmi Publications Pvt. Ltd., New Delhi, (16th edition)
3.	Gopal Ranjan and Rao, Basic and Applied Soil Mechanics, New Age International (P) Limited, New Delhi, 2002 (Second edition)
4.	Braja M. Das, Principles of Foundation Engineering, Thomson Asia Pvt. Ltd., Singapore, 2023
5.	Donald P. Coduto, Man-Chu Ronald Yeung and William A. Kitch, Geotechnical Engineering, Principles and Practices, PHI Learning Private limited, 2011.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Plan and execute soil exploration techniques including augur boring, soundings, sampling, and geophysical methods.
CO2	Apply Rankine's and Coloumb's theories to analyze active and passive earth pressures for different soil types.
CO3	Design foundations based on bearing capacity analyses and building codes, considering various types of failures.
CO4	Design and analyze shallow foundations such as spread, combined, trapezoidal, strap footings, and raft foundations, including settlement control.
CO5	Evaluate the load-carrying capacity and settlement of different types of piles, including groups, using static and dynamic methods.

CEPC21 ENVIRONMENTAL POLLUTION & CONTROL ENGINEERING

Course Code	**:**	CEPC21
Course Title	**:**	**Environmental Pollution & Control Engineering**
Type of Course	**:**	PC
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn the basics of sewage composition and its characteristics
CLO2	To have adequate knowledge about various sewage treatment processes and its design
CLO3	To provide the adequate information on various disposal standards for industrial effluents
CLO4	To study the effect of air pollution and its control measures
CLO5	To gain knowledge about solid waste disposal and Environmental Impact Assessment

Course Content

Domestic Sewage: Characteristics and composition – Sampling – Analysis – Population equivalent – Drainage in buildings – Plumbing systems for drainage - Sewer design; Treatment: Primary treatment – Secondary treatment – Biokinetics – Lagooning – Sludge digestion – Tertiary treatment; Disposal standards – Self-purification of rivers – Streeter Phelps equation – Oxygen sag curve; Industrial wastewater: Characteristics - Equalization and neutralization – Biological degradation – Recycle and reuse of waste effluents – treatment systems for different industries; Air pollution: Sources - Effects – Standards– Control devices; Solid waste management: Composition- Functional elements; Environmental Impact Assessment.

References

1	Peavy H. S., Rowe D. R. and Tchobanoglous G., Environmental Engineering, McGraw Hill, New York, 1985.

2	Davis M. L. and Cornwell D. A., Introduction to Environmental Engineering, Tata McGraw Hill Education Pvt. Ltd,. New Delhi, 2010.
3	Birdie, G. S. and Birdie, Water Supply and Sanitary Engineering, Dhanpat Rai & Sons, 2014.
4	Duggal, K. N., Elements of Environmental Engineering, S. Chand & Co., 2008. 5. Metcalf and Eddy, Wastewater Engineering, Collection, Treatment and Disposal, Tata McGraw Hill, Inc., New York, 2005
5	Peavy H. S., Rowe D. R. and Tchobanoglous G., Environmental Engineering, McGraw Hill, New York, 1985.
6	Manual on Water supply and Treatment – CPHEEO, 1999.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	determine the characteristics of sewage
CO2	design treatment units for wastewater
CO3	predict the quality of water in river using mathematical models
CO4	select suitable treatment units for specific industries
CO5	suggest suitable control measures for air pollution and solid waste management

CEPC22 IRRIGATION ENGINEERING AND HYDRAULIC STRUCTURES

Course Code	**:**	CEPC22
Course Title	**:**	**Irrigation Engineering and Hydraulic Structure**
Type of Course	**:**	PC
Prerequisites	**:**	CEPC12
Contact Hours	**:**	46
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn the fundamental principles and the necessity of irrigation, including different types and development in various regions.
CLO2	To comprehend soil classification, water retention, movement within soils, and measurement of soil moisture content.
CLO3	To determine crop water requirements, irrigation scheduling, and standards for irrigation water.
CLO4	To learn the purpose, components, and design of diversion headworks, weirs, barrages, and various types of dams.
CLO5	To study the classification, design, and maintenance of canals and other irrigation methods, and design hydraulic structures.

Course Content

Principles of Irrigation - Need for irrigation - Development of irrigation - National Water Policy - Tamil Nadu scenario -Type of irrigation. Plant water relationship - Soil classification,

Field capacity, permanent and temporary wilting point -Physical properties of soil that influence soil moisture characteristics - Concept of soil water potential and its components: Gravitational and Osmotic pressures- Retention of water in soils - Concept of available water - Movement of water into and within the soils - Measurement of soil moisture content.

Crop Water Requirement - Necessity and importance- Crop and crop seasons in India - Duty, Delta, Base Period- Factors affecting Duty-Irrigation efficiencies - Crop water demand Consumptive use of water - Irrigation requirements of crops - Irrigation scheduling: CROPWAT-Standards for irrigation water- Planning and Development of irrigation projects.

Diversion and Impounding Structures - Purpose and components of diversion Head works -Weirs and Barrages -Types of impounding structures - Factors affecting, location of dams -Forces on a dam -Design of Gravity dams; Earth dams, Arch dams - Spillways -Energy dissipaters- Structures on Pervious formations - Silt theories, Bligh's creep theory and Khoslas's theory, Weir and Barrages, Design of vertical drop weir.

Canal Irrigation - Classification of canals- Alignment of canals - Design of irrigation canals- Regime theories: Kennedy's theory, Lacey's theory - Canal Head works - Canal regulators - Canal drops -Cross drainage works and types- Canal Outlets, Escapes -Lining and maintenance of canals - Other methods of Irrigation: Surface, Subsurface - Merits and Demerits - waterlogging - Micro irrigation - sprinkler and drip - Irrigation scheduling using artificial intelligence.

Design of Hydraulic Structures - Design of Surplus Weir - Tank sluice - Design of Components of vertical weir - Canal drop - Canal Regulator - Check dam.

References

1	R.K. Sharma, Irrigation Engineering and Hydraulic Structures, Oxford and IBH Publishing Co., New Delhi, 2002.
2	R.K. Sharma and T.K. Sharma, "Irrigation Engineering", S. Chand and Company, New Delhi, 2008.
3	Mohana Krishnan, A few Novel and Interesting Innovative Irrigation Structures: Conceived, Designed and Executed in the Plan Projects in Tamil Nādu, Publ.No. 44 and Water Resources Development & Management Publ.No.43, IMTI Thuvakudy, Trichy, 2011
4	H.M. Raghunath, Irrigation Engineering, Wiley India Pvt. Ltd., New Delhi, 2011.
5	K.R. Arora, Irrigation, Water Power and Water Resources Engineering, Standard Publishers Distributors, New Delhi, 2009.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Ability to explain the necessity, development, and types of irrigation systems, along with national and regional water policies.
CO2	Proficiency in analysing soil properties, water retention, and soil moisture measurement techniques.
CO3	Competence in calculating crop water demand, consumptive use, and irrigation requirements using tools

CO4	Skills to design and evaluate diversion headworks, dams, spillways, and other impounding structures based on various theories and principles
CO5	Ability to design, align, and maintain canal irrigation systems, and apply modern irrigation methods like micro-irrigation, and use artificial intelligence for irrigation scheduling

CEPC23 RAILWAY, AIRPORT AND HARBOUR ENGINEERING

Course Code	**:**	CEPC23
Course Title	**:**	**Railway, Airport and Harbour Engineering**
Type of Course	**:**	PC
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To know about the basics and design of various components of railway engineering.
CLO2	To study about the types and functions of track, junctions and railway stations.
CLO3	To learn about the aircraft characteristics, planning and components of airport.
CLO4	To study about the types and components of docks and harbours.
CLO5	To know about various urban transportation systems and Intelligent Transportation Systems.

Course Content

Railway Engineering - Location surveys and alignment - Permanent way - Gauges - Components - Functions and requirements - Geometric design

Track Junctions-Points and crossings - types and functions - design and layout - simple problems - Railway stations and yards. Signaling and interlocking - control systems of train movements.

Airport Engineering-Aircraft characteristics - Airport obstructions and zoning - Runway - taxiways and aprons- Terminal area planning

Docks and Harbours - Types - Layout and planning principles- breakwaters - docks- wharves and quays - Transit sheds- warehouses- navigation aids.

Urban transportation systems - Bus transit - Mass Rapid Transit System - Light Rail

Transit. Transport economics and Financing - Intelligent Transportation Systems (ITS)

References

1	M.M. Agarwal, Railway Engineering, Prabha & Co. 2007.
2	Khanna, S.K. and Arora, M.G. Airport Planning and Design, Nemchand and Bros.

	1999.
3	Oza and Oza, Elements of Dock and Harbour Engineering, Charotar Publishing House, 1996.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Carry out the surveys for railways, airports and harbours.
CO2	Perform geometric design for the three modes.
CO3	Plan the layout of different types of terminals.
CO4	Apply the principles of bus transit, MRTS and LRT.
CO5	Demonstrate the fundamentals of Intelligent Transportation Systems.

CEPC24 DESIGN OF STEEL STRUCTURAL ELEMENTS

Course Code	**:**	CEPC24
Course Title	**:**	**Design of Steel Structural Elements**
Type of Course	**:**	PC
Prerequisites	**:**	CEPC15
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the provisions of IS800-2007 code of practice and apply this understanding to design axially loaded tension members.
CLO2	To study the behavior and design of compression using simple and built-up sections.
CLO3	To understand the behavior of flexural members and design the laterally restrained and unrestrained beams.
CLO4	To study the design of bolted connections and arranging field visit to industries.
CLO5	To study the design of welded connections and arranging field visit to industries.

Course Content

Introduction - elastic and plastic properties of steel sections – stress distribution under various internal forces. Design of axially loaded tension members - Types of tension members - modes of failures

Design of axially loaded compression members – Plastic moment and shape factor - section classifications - effective length - slenderness ratio – simple sections – built- up sections - design of lacings and battens - single angle and double angle strut – continuous and discontinuous strut.

Flexural members – types of steel beams – Lateral stability of beams –effective length - design of laterally restrained and unrestrained beams – rolled sections - built-up beams/compound beams – Design for strength and serviceability, web yielding, web

crippling, bearing stiffeners.

Bolted connections - types of bolts - resistance of bolted connections under various failure modes – shear moment resistant connections - design of beam and columns splice.

Welded connections - types - strength of welds - design of fillet and butt welds - shear and moment resistant connections - design and detailing of connections. Note: Assignments include the design and drawings of various steel structural elements.

References

1	Subramanian N, Design of Steel Structures, Oxford University Press, New Delhi 2008.
2	Shiyekar, M.R., Limit State Design in Structural Steel, PHI, 2013.
3	Bhavikatti, S.S., Design of Steel Structures, I.K. International Publishing House Pvt. Ltd., New Delhi, 2010
4	IS 800 - 2007, Code of practice for general construction in steel, Bureau of Indian Standards, New Delhi.
5	SP6 (1)-1964, IS hand book for structural Engineers. Bureau of Indian Standards, New Delhi.
6	Online Teaching Material – Institute for Steel Development and Growth (INSDAG)

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Apply the IS code of practice for the design of steel structural elements.
CO2	Design compression using simple and built-up sections.
CO3	Understand the behavior of flexural members and design the laterally restrained and unrestrained beams.
CO4	Analyze the behavior of bolted connections and design them.
CO5	Design welded connections for both axial and eccentric forces.

PROGRAM ELECTIVES

STREAM I: CONSTRUCTION TECHNOLOGY AND MANAGEMENT

CEPE10 CONSTRUCTION TECHNIQUES AND EQUIPMENTS

Course Code	**:**	CEPE10
Course Title	**:**	**Construction Techniques and Equipment**
Type of Course	**:**	PE
Prerequisites	**:**	-
Contact Hours	**:**	36 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn the principles of construction of building components
CLO2	To learn the various construction techniques and their application in real-world projects
CLO3	To learn the application of prefabricated construction and building services in real-world projects
CLO4	To learn the different types of construction equipment and analyse the planning and operation of various equipment in project sites
CLO5	To comprehend the application of Industry 4.0 technologies in construction

Course Content

Principles of Construction, Different Construction Techniques, Bonding, Reinforced Brickwork, Stone Masonry, Hollow Block Masonry, Composite Masonry, Cavity Walls, Flooring, Formwork, Centering and Shuttering Sheet Piles, Slip and Moving Forms, Roofs and Roof Covering, Joints in Concrete, Plastering and Pointing, Shoring and Scaffolding, Underpinning, Submerge Structures

Prefabricated Structures and Building Services, Prefabricated Panels and Structures, Production, Transportation and Erection of Structures, Sound Insulations, Ventilations, Fire Resisting Construction, Damp Proofing, Termite Proofing

Basics of Construction Equipment, Types of Equipment, Earthwork Equipment, Hoisting and Lifting Equipment, Material Handling Equipment, Concrete Equipment, Dewatering Equipment, Graders, Scrapers, Rollers

Factors Affecting the Selection of Equipment, Economic Life of Equipment, Cost of Equipment, Maintenance of Equipment

Automation and Robotics in Construction, 3D printing and its application, Industry 4.0 Application in Construction Techniques and Equipment

References

1.	Peurifoy, R.L., Schexnayder, J.C., and Shapira, A. (2010). Construction Planning, Equipment and Methods, Tata McGraw Hill, New Delhi.

2.	Varghese, P. C. Building construction. PHI Learning Pvt. Ltd., 2016.
3.	Sharma S.C. (2013). Construction Equipment and Management, Khanna Publishers, New Delhi.
4.	Schaufelberger, J. E., & Migliaccio, G. C. (2019). Construction equipment management. Routledge.
5.	Sawhney, A., Riley, M., Irizarry, J., & Riley, M. (2020). Construction 4.0. Sawhney, A., Riley, M., Irizarry, J., Eds.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Understand the principles of construction of building components
CO2	Assess the use of various construction techniques and their application in real-world projects
CO3	Assess the application of prefabricated construction and building services in real-world projects
CO4	Comprehend the use of different construction equipment and analyse the planning and operation of various equipment in project sites
CO5	Comprehend and assess the application of Industry 4.0 technologies in construction

CEPE11 CONSTRUCTION MANAGEMENT

Course Code	**:**	CEPE11
Course Title	**:**	**Construction Management**
Type of Course	**:**	PE
Prerequisites	**:**	-
Contact Hours	**:**	36 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand and learn the managerial duties and responsibilities of a construction/project manager
CLO2	To learn and estimate time and cost with regard to manpower, materials and equipment of a construction projects
CLO3	To learn and apply concepts related to project planning and scheduling
CLO4	To learn the types of construction contracts and their drafting
CLO5	To learn the application of software in construction management

Course Content

Introduction, Construction Project Lifecycle and its Phases, Project Formation, Management Objectives and Functions, Organisational Chart of a Construction Organisation/Project, Construction/Project Manager's Duties and Responsibilities, Public Relations

Resource Requirements for a Construction Project, Manpower Planning, Training, Recruitment, Motivation, Welfare Measures and Safety Laws, Machinery for Construction Projects, Factors Affecting Selection of Equipment and Machinery, Cost-Benefit Estimation

Project Scope and Specification, Project Planning and Scheduling, Planning Stages, Construction Schedule Preparation, Bar Chart, Network Formulation and Time Computation – CPM and PERT, Schedule Monitoring and Control

Contract Management, Types of Contracts, Formation of Contract, Contract Conditions, Drafting of Contract Documents, Contract Problems, Arbitration and Legal Requirements, Risk Management in Projects, Leadership, Stakeholder Management and Teamwork in Construction Projects and Organisation, Ethics, Morale, Delegation and Accountability, Project Handing Over

Computer Applications in Construction Management, Software for Project Planning, Scheduling and Control, Construction 4.0

References

	Oberlender, G. D., & Oberlender, G. D. (2014). Project management for engineering and construction. New York: McGraw-Hill.
2.	Jha, K. N. (2015). Construction Project Management: Theory and Practice. Pearson Education India.
3.	Harris, F., McCaffer, R., Baldwin, A., & Edum-Fotwe, F. (2021). Modern construction management. John Wiley & Sons.
4.	Sawhney, A., Riley, M., & Irizarry, J. (Eds.). (2020). Construction 4.0: An Innovation Platform for the Built Environment. Routledge.
5.	Sears, S. K., Sears, G. A., & Clough, R. H. (2010). Construction project management: A practical guide to field construction management. John Wiley & Sons.
6.	Walker, A. (2015). Project management in construction. John Wiley & Sons.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Perform the role of a construction/project manager efficiently with precise knowledge of the roles and responsibilities
CO2	Analyse and estimate the resources required for a construction project
CO3	Apply project planning and scheduling tools to estimate the time and cost of a construction project
CO4	Comprehend and apply knowledge of construction contracts and report contractual issues in projects
CO5	Appreciate and apply software in construction management

CEPE12 PROJECT PLANNING, SCHEDULING AND CONTROL

Course Code	**:**	CEPE12
Course Title	**:**	**Project Planning, Scheduling and Control**
Type of Course	**:**	PE
Prerequisites	**:**	-
Contact Hours	**:**	36 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand fundamental project management concepts and principles
CLO2	To learn principles and processes related to project scope management
CLO3	To comprehend concepts and tools related to project scheduling and their applications in real-world projects
CLO4	To gain knowledge of advanced project scheduling tools
CLO5	To assess the use of advanced technology platforms in project scheduling and control

Course Content

Introduction to Projects, Types of Projects, Introduction to Construction Project Management, Project Lifecycle and its Phases, Key Activities Involved in Different Project Lifecycle Phases, Role of Various Stakeholders in Different Project Lifecycle Phases, Project Organisation Structure and its Types

Gathering Project Requirements, Project Scope and Specifications, Project Scope Matrix, Project Contract Management, Work Breakdown Structure (WBS), WBS Types, Creating WBS, Scope Management Steps and Processes

Project Planning, Planning and Scheduling, Steps Involved in Project Planning, Networking and Non-Networking Techniques Scheduling Techniques, Gantt-Chart, Formulation and Applications of Critical Path Method (CPM), Program Evaluation & Review Technique (PERT) and Precedence Diagram Method (PDM), Introduction to Linear Scheduling Methods

Time-Cost Tradeoff, Earned Value Management (EVM), Crashing and Fast-tracking Projects, Resource Constrained Scheduling, Resource Levelling, Schedule Updation and Project Control

Software Applications and Use of AI in Project Planning, Scheduling and Control, Data-driven Decision Making

References

1	Oberlender, G. D., & Oberlender, G. D. (1993). Project management for engineering and construction (Vol. 2). New York: McGraw-Hill.
2	Sears, S. K., Sears, G. A., & Clough, R. H. (2010). Construction project management: A practical guide to field construction management. John Wiley & Sons.

3	Callahan, M. T., Quackenbush, D. G., & Rowings, J. E. (1992). Construction project scheduling.
4	Guide, P. M. B. O. K. (2008). A guide to the project management body of knowledge.
5	Mubarak, S. A. (2015). Construction project scheduling and control. John Wiley & Sons.
6	Wiest, J. D. (1977). A management guide to PERT/CPM; with GERT/PDM/DCPM and other Networks.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Understand the fundamental project management concepts and principles
CO2	Comprehend the principles and processes related to project scope management
CO3	Gain the ability to apply concepts and tools related to project scheduling in real-world projects
CO4	Comprehend the use of advanced project scheduling tools
CO5	Assess the use of advanced technology platforms in project scheduling and control

CEPE13 QUALITY AND SAFETY MANAGEMENT IN CONSTRUCTION PROJECTS

Course Code	**:**	CEPE13
Course Title	**:**	**Quality and Safety Management in Construction Projects**
Type of Course	**:**	PE
Prerequisites	**:**	-
Contact Hours	**:**	36 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	Understand the principles and significance of quality management in construction
CLO2	Understand the roles and responsibilities of quality managers and apply quality principles and tools in project-based scenarios
CLO3	Comprehend standards and regulations related to construction quality management
CLO4	Understand the roles and responsibilities of safety managers and apply safety principles and tools in project-based scenarios
CLO5	Comprehend standards and regulations related to construction safety management

Course Content

Construction Quality Management, Introduction to Quality, Significance of Quality in Different Phases of a Project, Planning and Control of Quality during Design Phase of a Project, Quality Aspects during Procurement Phase of a Project, Quality Aspects during

Construction Phase of a Project.

Quality Aspects of Construction Materials – Specifications and Tolerances, Inspection of Materials and Machinery, Preparation of Quality Manuals, Checklist and Inspection Report, Establishing Quality Assurance System.

Different Quality Management Tools, Quality Standards/Codes in Design and Construction, Total Quality Management Concepts – ISO 9000 Family of Standards, Concepts of Quality Assurance (QA) and Quality Control (QC), QA/QC Systems and Organizations in Construction Context, Quality Audits.

Construction Safety Management, Introduction to Concepts Related to Construction Safety, Factors Affecting Construction Safety, Roles, Duties and Responsibilities of Workers, Supervisors, Managers and Owners, Safety Program Components – Safety Committee, Safety Training, Incentives and Monitoring ISO 45001 (2018) Standard for Health and Safety at Work, Safety Procedures for Key Construction Operations, Safety Checklists, Manuals, and Audits, Introduction to Key Safety Laws.

References

1	Jimmy W. Hinze, (2013), Construction Safety, Pearson College Division, 2nd Edition.
2	Richard J Coble, Jimmy W. Hinze& Theo C Haupt, (2000) Construction Safety and Health Management, Pearson.
3	John L Ashford, (2002) The Management of Quality in Construction, Routledge, 1st edition.
4	Gryna, F. M. (2001), Quality planning and analysis: from product development through use (Mcgraw-Hill Series in Industrial Engineering and Management Science) 3rd Edition
5	Grant E.L., and Leavens worth,(1980), "Statistical Quality Control", Mc Graw Hill.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Comprehend the significance and nuances of quality management in construction
CO2	Perform the role of quality engineers/managers and gain the ability to apply quality principles and tools in project-based scenarios
CO3	Comprehend standards and regulations related to construction quality management that need to be followed at workplace
CO4	Perform the role of safety engineers/managers and gain the ability to apply safety principles and tools in project-based scenarios
CO5	Comprehend standards and regulations related to construction safety management that need to be followed at workplace

CEPE14 ESTIMATION AND COSTING IN CIVIL ENGINEERING

Course Code	**:**	CEPE14
Course Title	**:**	**Estimation and Costing in Civil Engineering**
Type of Course	**:**	PE
Prerequisites	**:**	
Contact Hours	**:**	36 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand and learn the basic concepts related to estimating and costing in construction
CLO2	To learn how to estimate the quantities of items of works involved in buildings, water supply and sanitary works, road works and irrigation works
CLO3	To learn how to estimate key project resources such as labour, material, and plant and machinery (LMP) and carry out rate analysis
CLO4	To examine and apply concepts related to the valuation of buildings and structures
CLO5	To know how to write reports on the estimation of key construction structures

Course Content

Introduction to Estimation, Necessity of Estimation, Units and Measurements, Types of Estimates, Methods of Estimation, Load Bearing and Framed Structures

Calculation of Quantities of Brickwork, RCC, PCC, Plastering, Whitewashing, Colour Washing and Painting/Varnishing for Shops, Rooms, Residential Buildings with Flat and Pitched Roofs, Various Types of Arches – Calculation of Brickwork and RCC Works in Arches – Estimate of Joineries for Panelled and Glazed Doors, Windows, Ventilators, Handrails, Estimation of Steel for RCC Works

Estimating of Septic Tank, Soak Pit, Sanitary and Water Supply Installations, Water Supply Pipeline, Sewer Line, Tube Well and Open Well, Estimate of Bituminous and Cement Concrete Roads, Estimate of Retaining Walls

Schedule of Rates, Analysis of Rates, Specifications – Detailed and General Specifications for Buildings, Roads, Tenders, Contracts, Types of Contracts, Arbitration and Legal Requirements - Basics of Value Engineering, Capitalised Value, Depreciation, Escalation, Calculation of Standard Rent, Mortgage, Lease-Valuation of Building, Loss Assessment

Introduction to Engineering Economics – Time Value of Money, Discounted Cash Flows, Evaluating Alternatives, Principles for Report Preparation – Report on Estimate of Official Building, Roads, Water Supply and Sanitary Installations

References

1	Dutta, B. N. (2021). Estimating and Costing in Civil Engineering, UBS Publishers & Distributors Pvt. Ltd.
2	Kohli, D. D. and Kohli, R. C. (2013). A Text Book of Estimating, Costing and Accounts

	(Civil), S. Chand & Company Ltd.
3	Holm, L. and Schaufelberger, J. E. (2021). Construction cost estimating. Routledge.
4	Brook, M. (2016). Estimating and tendering for construction work. Routledge.
5	Anil Kumar, M. (2003). Value Engineering: Concept, Technique and Application, SAGE Publishers.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Understand and learn the basic concepts related to estimating and costing in construction
CO2	Apply and gain the ability to estimate the quantities of items of works involved in buildings, water supply and sanitary works, road works and irrigation works
CO3	Apply and gain the ability to estimate key project resources such as labour, material, and plant and machinery (LMP) and carry out rate analysis
CO4	Comprehend and apply concepts related to the valuation of buildings and structures
CO5	Able to write reports on the estimation of key construction structures

CEPE15 LEAN CONCEPTS AND TOOLS IN CONSTRUCTION PROJECTS

Course Code	**:**	CEPE15
Course Title	**:**	**Lean Concepts And Tools In Construction Projects**
Type of Course	**:**	PE
Prerequisites	**:**	-
Contact Hours	**:**	36 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To develop a basic understanding of lean thinking and its application in construction context
CLO2	To understand different types of waste generated in construction and how it can be managed
CLO3	To understand various factors affecting construction productivity and analyse the approaches for productivity improvement in project sites
CLO4	To learn the application of various lean construction tools at project sites
CLO5	To analyse the implementation challenges of lean construction

Course Content

Manufacturing Vs. Construction Supply Chains, Evolution of Management Manufacturing Vs. Construction Supply Chains, Evolution of Management Principles – Total Quality Management, Six Sigma and Lean, Overview and Introduction to Lean Thinking in Construction Context -

Introduction to Waste and Value, Types of Waste, Construction Productivity, Productivity

Measurement, Factors Affecting Construction Productivity, Productivity Improvement Approach

Lean Tools in Construction-I – Work Sampling, Value Stream Mapping, Foreman Delay Surveys, Crew Balance Chart, Case Studies

Lean Tools in Construction-II – 5S, Last Planner System, Big Room Approach and Secondary Lean Tools, Case Studies

Implementation of Lean Construction in Project Sites and Organisations, Lean Culture, Overview of Lean in Design and Supply Chain Management, Integrated Project Delivery Strategy

References

1	Tzortzopoulos, P., Kagioglou, M., & Koskela, L. (Eds.). (2020). Lean construction: Core concepts and new frontiers. Routledge.
2	Rubrich, L. (2012). An introduction to lean construction: Applying lean to construction organizations and processes. WCM Associates LLC.
3	Forbes, L. H., & Ahmed, S. M. (2010). Modern construction: lean project delivery and integrated practices. CRC press.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Understand the relevance of lean thinking and its application in construction context
CO2	Assess the different types of waste generated in construction and how it can be managed
CO3	Analyse the various factors affecting construction productivity and means for improving productivity in project sites
CO4	Apply and gain the ability to realise the benefits of lean tools application in project sites
CO5	Comprehend and analyse the challenges in implementation of lean construction

CEPE16 PROJECT RISK MANAGEMENT

Course Code	**:**	CEPE16
Course Title	**:**	**Project Risk Management**
Type of Course	**:**	PE
Prerequisites	**:**	
Contact Hours	**:**	36 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the significance of uncertainties and risks in the context of construction projects and businesses
CLO2	To learn the various risk management frameworks and apply them in the context

	of construction projects
CLO3	To learn and apply various risk identification and risk analysis tools in the context of construction projects
CLO4	To assess and implement the various risk management strategies in projects
CLO5	To comprehend the role of key stakeholders in the context of construction project risk management

Course Content

Overview and Importance of Risks and Uncertainties in Projects, Types of Project Risks, Quantifiable and Un-Quantified Risks

Risk Ownership, Risk Breakdown Structure, Project Risk Management Cycle, Different Project Risk Management Frameworks

Project Risk Identification and its Methods, Project Risk Assessment, Quantitative and Qualitative Risk Analysis Methods, Quantitative – Sensitivity Analysis, Decision Tree, Scenario and Monte Carlo Analysis, Qualitative – Probability Impact Matrix, Risk Categorisation, Expert Judgement, Brainstorming, Various Risk Management Strategies, Residual and Secondary Risks, Risk Register

Addressing and Devising Project Risk Management Implementation Strategies, Project Risk Communication, Involvement of Stakeholders in Risk Management, and Risk Management Culture in Projects and Organisations

Micro, Market, Project Level Risk Analysis Approach, Risk Analysis, and Management for Projects (RAMP), Details of RAMP Process, Identifying Risk Events in Projects, Probability Distribution.

References

1	Bartlett, J. (2004). Project risk analysis and management guide. APM Publishing Limited.
2	Institution of Civil Engineers, & Institute and Faculty of Actuaries. (2014). Contents and Preliminary Pages. Risk Analysis and Management for Projects. ICE Publishing, United Kingdom.
3	Chapman, C., & Ward, S. (2003). Project risk management processes, techniques and insights. John Wiley & Sons Ltd.
4	K. K. Chitkara. (2019). Construction Project Management, 4th Edition, Tata Mcgraw Hill Publication, India.
5	Smith, N. J., Merna, T., & Jobling, P. (2014). Managing risk in construction projects. John Wiley & Sons.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Understand and assess the significance of uncertainties and risks in the context of construction projects and businesses
CO2	Learn and apply the various risk management frameworks in the context of

	construction projects
CO3	Learn and gain the ability to apply the various risk identification and risk analysis tools in the context of construction projects
CO4	Assess and implement the various risk management strategies in projects
CO5	Comprehend and gain the ability to examine the role of key stakeholders in the context of construction project risk management

CEPE17 PROJECT AND BUSINESS STRATEGY MANAGEMENT IN CONSTRUCTION

Course Code	**:**	CEPE17
Course Title	**:**	**Project and Business Strategy Management in Construction**
Type of Course	**:**	PE
Prerequisites	**:**	
Contact Hours	**:**	36 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the concepts related to strategy management in construction projects and businesses
CLO2	To comprehend the role of management in strategy formation and management
CLO3	To learn and apply strategy management frameworks and models in the context of construction projects and organisations
CLO4	To analyse different types of strategies in construction projects and organisations
CLO5	To assess the implementation of strategy management evaluation and strategy performance

Course Content

Introduction To Strategic Management Concepts, Introduction to Strategy in Construction Project and Business Context, Purpose, Objectives, Goals, Policies and Programs

7-S Framework, Board of Directors – Roles, Responsibilities, Structure and Composition, Role of Top Management in Project and Business Strategic Management

Strategic Management Process – in Project and Business Context, SWOT Analysis, Macro and Micro Environmental Factors, Importance of Value Chain, Decision and Analytical Tools, Factors Driving Industry Change, Key Factors for Success in Organization, Overall Cost Leadership, Focus and Differentiation Strategies

Financial Strategies, Growth Strategy, Stabilization Strategy and Retrenchment Strategy, Portfolio Strategies G.E, BCG & Arthur D. Little's Model.

Strategy Implementation, Strategy Evaluation and Control, Evaluation of Strategic Performance – Performance Gap, ROI, Budget and Financial Ratios, Strategy Audit

References

1	Langford, D., & Male, S. (2008). Strategic management in construction. John Wiley & Sons.
2	Fellows, R. F., Langford, D., Newcombe, R., & Urry, S. (2009). Construction management in practice. John Wiley & Sons.
3	Harris, F., McCaffer, R., Baldwin, A., & Edum-Fotwe, F. (2021). Modern construction management. John Wiley & Sons.
4	McCabe, S. (2010). Corporate strategy in construction: Understanding today's theory and practice. John Wiley & Sons.
5	Winch, G. M. (2009). Managing construction projects. John Wiley & Sons.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Understand the concepts related to strategy management in construction projects and businesses
CO2	Comprehend the role of management in strategy formation and management
CO3	Learn and gain the ability to apply strategy management frameworks and models in the context of construction projects and organisations
CO4	Analyse the implementation outcomes of different types of strategies in construction projects and organisations
CO5	Gain the ability to assess the implementation of strategies and their performance in projects and organisations

CEPE18 INFRASTRUCTURE PROJECT DELIVERY AND MANAGEMENT

Course Code	**:**	CEPE18
Course Title	**:**	**Infrastructure Project Delivery and Management**
Type of Course	**:**	PE
Prerequisites	**:**	-
Contact Hours	**:**	36 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand how infrastructure projects are conceptualised and planned and the various project lifecycle phases
CLO2	To learn concepts related to the feasibility of infrastructure projects, infrastructure economics and finance
CLO3	To understand and assess the occurrence of various risks and its management strategies in the context of infrastructure projects
CLO4	To examine the role of various internal and external stakeholders and their management strategies in the context of infrastructure projects
CLO5	To provide exposure to new technological advancements and new contract

	management models in the context of infrastructure projects

Course Content

Overview of Infrastructure Sectors in India and in International Contexts, Policies and Programs in India by the Central and Various State Governments, Phases of an Infrastructure Project and Key Players, Role of Government, Private Agencies, NGOs and Construction Organisations

Project Feasibility Studies, Infrastructure Economics and Finance – Concepts, Tools and Processes, Public-Private Partnerships, Case Studies

Risk Management in Infrastructure Projects, Types of Risks, Risk Identification Techniques and Risk Analysis, Addressing Risks, Case Studies

Internal and External Stakeholders, Stakeholder Roles and Responsibilities, Stakeholder Mapping, Stakeholder Engagement and Management Strategies, Case Studies

Infrastructure Megaprojects and Technological Advancements, Overview of Flexible Contracts and Relational Contracts in Infrastructure Projects

References

1	Goodman, A. S. and Hastak, M. (2006). Infrastructure planning handbook: Planning, engineering, and economics. McGraw-Hill Education.
2	Miller, R. and Lessard, R. D. (2001). The Strategic Management of Large Engineering Projects: Shaping Institutions, Risks, and Governance, MIT Press, Massachusetts. https://doi.org/10.7551/mitpress/6478.001.0001
3	Ashish Kumar Srivastava and Iva Ashish Srivastava. (Ed.). (2023). Administration in India: Challenges and Innovation, Routledge, London. https://doi.org/10.4324/9781003433187
4	Bent Flyvbjerg (ed.). (2017). The Oxford Handbook of Megaproject Management, Oxford University Press. https://doi.org/10.1093/oxfordhb/9780198732242.001.0001
5	Assorted readings from Journal papers, conference papers, and other website sources prior to each class.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Understand how infrastructure projects are conceptualized and planned and the various project lifecycle phases
CO2	Comprehend and apply concepts related to the feasibility of infrastructure projects, infrastructure economics and finance
CO3	Assess and gain the ability to identify various risks and apply management strategies to address them
CO4	Comprehend and examine the role of various internal and external stakeholders and their management strategies in the context of infrastructure projects
CO5	Assess the application of new technological advancements and new contract management models in the context of infrastructure projects

CEPE19 SUSTAINABLE PRACTICES IN CONSTRUCTION

Course Code	**:**	CEPE19
Course Title	**:**	**Sustainable Practices in Construction**
Type of Course	**:**	PE
Prerequisites	**:**	-
Contact Hours	**:**	36 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the basics of why sustainable construction practices are important for the present and future economies
CLO2	To learn and assess the various types of energy use in buildings
CLO3	To learn and apply life cycle assessment (LCA) techniques in the context of building construction
CLO4	To comprehend the use of various green rating standards in building construction
CLO5	To provide exposure to social aspects of sustainability in the construction industry

Course Content

Introduction to Sustainability, Sustainable Practices in Construction, Three Dimensions of Sustainability, Environment, Economy and Social Aspects, Building Life Cycle, Resource Use in the Built Environment

Life Cycle Energy Use in Buildings, Various Types of Energy, Embodied Energy, Onsite Construction Energy, Operational Energy and Demolition Energy, Methods to Reduce Life Cycle Energy Use

Life Cycle Assessment (LCA), Introduction to Different LCA Methods – Process LCA, EIO-LCA and Hybrid LCA, Carbon Footprint, Parameters that Influence Emissions in Building Construction, Methods to Calculate Emissions and Carbon Calculators, Introduction to Net-Zero Energy Buildings

Green Building Ratings – Overview and Use of LEED, GRIHA, BREEAM, Green Globes, CASBEE, ICC-ES

Social Aspects of Sustainability in Construction, Occupational Health and Safety of Construction Workers, Introduction to Sustainable Civil Infrastructure Development, Principles of Green Engineering

References

1	Adler, A., Armstrong, J., Azerbegi, R., Guy, G.B., Fuller, S.K., Kalin, M., Karolides, A., Lelek, M., Lippiatt, B., Macaluso, J., Spencer, E., Waier, P., Walker, A., Green Building: Project Planning and Cost Estimating, Second Edition, RS Means, Reed Construction Data, Inc., 2006.
2	Hendrickson, C. T., Lave, L. B., & Matthews, H. S. (2010). Environmental life cycle assessment of goods and services: an input-output approach. Routledge.

3	Liv Haselbach, The Engineering Guide to LEED-New Directions (Green Source): Sustainable construction, McGraw-Hill Professional, 2008.
4	Martin Melaver and Phyllis Mueller, The Green building Bottom line: The real cost of sustainable building, McGraw-Hill Professional, 2008
5	Indian Green Building Council, Green building rating system: New construction and major renovations (LEED-India NC) reference guide version 1.0, Confederation of Indian Industry, CII-Sohrabaji Godrej Green Business Centre, Hyderabad, 2007.
6	The Energy and Resources Institute Press, Green Rating for Integrated Habitat Assessment (GRIHA), Ministry of New and Renewable Energy and The Energy and Resources Institute, New Delhi, 2010.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Understand the importance of sustainable construction practices in the context of present and future economies
CO2	Learn and assess the various types of energy use in buildings
CO3	Apply and gain the ability to utilise life cycle assessment (LCA) techniques in the context of building construction
CO4	Comprehend the use of various green rating standards in building construction
CO5	Comprehend the aspects of social sustainability in the construction industry

STREAM II: ENVIRONMENTAL ENGINEERING

CEPE20 AIR POLLUTION MANAGEMENT

Course Code	**:**	CEPE20
Course Title	**:**	**Air Pollution Management**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC17
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To provide general understanding of air quality and its impact on the environment
CLO2	To learn the fundamentals of meteorology and stability of atmosphere
CLO3	To study the fate and transport of air pollutants and its measurement techniques
CLO4	To discuss the different control methods and its principles for gaseous pollutant
CLO5	To know the sources and control of indoor air pollution

Course Content

Air pollutants – Sources – Classification of air pollutants – Particulates and gaseous pollutants – Effects of air pollutants on human health, vegetation and property – Global issues and air pollution – Global warming – Ozone layer depletion – Ambient air quality and emission standards – Air pollution indices – Air act;

Fundamentals of meteorology – Wind roses – Atmospheric stability – Atmospheric diffusion of pollutants – Transport, transformation and deposition of air contaminants – Plume behaviour – Atmospheric diffusion theories – Plume rise – Gaussian dispersion models;

Control principles – Principles and equipment description of control technologies – Particulates control by Gravitation, centrifugal, filtration, scrubbing, electrostatic precipitation – Absorption, adsorption, condensation, incineration and biofiltration for control of gaseous air pollutants – Biological air pollution control technologies – Bioscrubbers, biofilters;

Air pollutants in indoor environments – Levels of pollutants in indoor and outdoor air – Indoor air pollution from outdoor sources – Measurement methods – Control Technologies.

References

1.	Anjaneyulu, D., Air Pollution and Control Technologies, Allied Publishers, Mumbai, 2002.
2.	Rao, C. S., Environmental Pollution Control Engineering, New Age International, New Delhi, 2006.
3.	Rao, M. N. and Rao H. V. N., Air Pollution, Tata McGraw-Hill, New Delhi, 2007.
4.	W. L. Heumannn, Industrial Air Pollution Control Systems, McGraw-Hill, New York, 1997.
5.	Davis M. L. and Cornwell D. A., Introduction to Environmental Engineering, Tata McGraw Hill Education Pvt. Ltd,. New Delhi, 2010.
6.	Peavy H. S., Rowe D. R. and Tchobanoglous G., Environmental Engineering, McGraw Hill, New York, 1985.

Course Outcomes (CO)

At the end of the course student will be able

CO1	identify the types and sources of air pollutants
CO2	predict the effects of air pollutants on human health and the environment
CO3	choose appropriate technologies for removal of air pollutants
CO4	measure the pollutant concentration in indoor environment
CO5	suggest the control techniques for indoor air pollution

CEPE21 INDUSTRIAL WASTEWATER TREATMENT

Course Code	**:**	CEPE21
Course Title	**:**	**Industrial Wastewater Treatment**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC17
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To study characteristics of industrial wastewater and its effects
CLO2	To know the quality of industrial effluents before disposal
CLO3	To learn various treatment techniques for industrial wastewater
CLO4	To gain knowledge about the reuse of treated industrial effluents
CLO5	To familiarize various wastewater treatment facility adopted in industries

Course Content

Industrial wastewater: Characteristics – Environmental impacts – Effects- Effluent standards –– Regulatory requirements; Prevention Vs control of industrial pollution: Source reduction-Volume reduction – Process Modification – Strength reduction – Waste minimization strategies;

Treatment of industrial wastewater: Equalization and neutralization – Separation of solids – Removal of organic and inorganic solids – Oil separation – Precipitation –– Biological treatment methods – Aerobic and anaerobic methods - Chemical oxidation – Advanced oxidation processes - Photocatalysis –Adsorption– Ion exchange - Membrane methods – Reverse Osmosis - Electrochemical methods – Nutrient removal – Land treatment;

Sludge production and its management – Quantification and characteristics of sludge – Treatment of sludge and its disposal; Reuse of industrial wastewater– Zero effluent discharge systems; Case studies of wastewater treatment units in industries.

References

1.	Eckenfelder, W. W., Industrial Water Pollution Control, McGraw Hill, 2014.
2.	Nemerow N. L., Industrial Water Pollution, Addison-Wesley Publishing Company Inc., USA, 1978.
3.	Narayana Rao M. and Amal K. Dutta, Wastewater Treatment, Oxford & IBH Publishing Co., Pvt., Ltd., New Delhi, 2001.
4.	Bhatia S. C., Handbook of Industrial Pollution and Control, Volume I & II, CBS Publishers, New Delhi, 2003
5.	Mahajan, S. P., Pollution Control in Process Industries, Tata McGraw Hill Publishing company, New Delhi, 1991.

Course Outcomes (CO)

At the end of the course student will be able

CO1	recognize various environmental impacts due to improper management of industrial wastewater
CO2	propose strategies for the prevention and control of industrial pollution
CO3	determine appropriate technologies for the treatment of industrial wastewater
CO4	suggest safe sludge disposal techniques to minimize environmental risks
CO5	recommend the implementation of zero effluent discharge systems in industries

CEPE22 ENVIRONMENTAL MANAGEMENT AND IMPACT ASSESSMENT

Course Code	**:**	CEPE22
Course Title	**:**	**Environmental Management and Impact Assessment**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC17
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn the importance of environmental impact assessment (EIA) in various development projects
CLO2	To study the legal provisions on EIA and EIA notifications
CLO3	To brief the various methodologies involved in EIA
CLO4	To familiarize prediction tools for the assessment of different environmental impacts
CLO5	To describe the concepts of environmental management system

Course Content

Impacts of development projects on environment and Environmental Impact Assessment (EIA) and Environmental Impact Statement (EIS) – Objectives – EIA Types – EIA in project cycle – Capacity and limitations – Legal provisions on EIA – Environmental Impact Assessment notification – Environmental Impact Assessment consultants. Methods of categorization of industries for EIA – Elements of EIA – Process screening - baseline studies – mitigation – matrices – checklist;

Methods of EIA– Strength, weakness and applicability – Appropriate methodology solution; Prediction and Assessment of Impact on land – water – air - noise and energy - flora and fauna - Socio economic impact – Mathematical models for impact prediction - rapid EIA - public participation – Post environmental audit;

Plan for mitigation of adverse impact on environment – Options for impact mitigation; Addressing the issues related to the project affected people – Environment Management Plan – ISO 14000

References

1.	Canter, R. L., Environmental Impact Assessment, McGraw Hill Inc., New Delhi 1996.
2.	Anjaneyulu, Y., Environmental Impact Assessment Methodologies, B. S. Publications, Hyderabad, 2002.
3.	S. K. Shukla and P. R. Srivastava, Concepts in Environmental Impact Analysis, Common Wealth Publishers, New Delhi, 1992.
4.	John G. Rao and David C. Hooten (Ed.), Environmental Impact Analysis Handbook, McGraw Hill Book Company, 1990.

Course Outcomes (CO)

At the end of the course student will be able

CO1	analyse the environmental impacts of proposed projects
CO2	categorize the type of EIA required as per the EIA notification
CO3	predict and assess the impact on the environment
CO4	propose mitigation measures to avoid environmental impacts
CO5	prepare the EIA report with environmental management plan

CEPE23 SOLID WASTE MANAGEMENT TECHNIQUES

Course Code	**:**	CEPE23
Course Title	**:**	**Solid Waste Management Techniques**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC17
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the sources, types and composition of municipal solid waste
CLO2	To acquire knowledge on source reduction, segregation and storage of wastes
CLO3	To familiarize the different waste collection systems and their analysis
CLO4	To study the importance of transfer stations and processing technologies for resource recovery
CLO5	To know the concept of landfill disposal for municipal solid waste

Course Content

Municipal Solid Waste (MSW): Sources - Types – Generation rates - Composition - Characteristics - Sampling – Effects of improper disposal – Public health and environmental effects;

Functional Elements of MSW management: Source reduction – Reuse and Recycling – Source Segregation – Onsite storage – Collection - Transfer and transport – Transfer stations - Waste Processing technologies - Biological and chemical conversion technologies – Resource recovery – Composting - Biomethanation – Thermal processing options;

Sanitary landfill: Site selection - Design - Operation – Landfill liners – Management of leachate and landfill gas – Landfill post closure and environmental monitoring; Landfill bioreactor; Dumpsite rehabilitation.

References

1.	George Tchobanolglous and Frank Kreith Handbook of Solid Waste Management, McGraw Hill, New York, 2002.
2.	Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban

	Development, Government of India, New Delhi, 2000.
3.	Peavy H. S., Rowe D. R. and Tchobanoglous G., Environmental Engineering, McGraw Hill, New York, 1985.
4.	Davis M. L. and Cornwell D. A., Introduction to Environmental Engineering, Tata McGraw Hill Education Pvt. Ltd, New Delhi, 2010.
5.	Bhide A. D. and Sundaresan, B. B. Solid Waste Management Collection, Processing and Disposal, 2001.
6.	Manser A. G. R and Keeling A. A, Practical Handbook of Processing Recycling of Municipal Solid Wastes, Lewis Publishers, CRC Press, 1996.

Course Outcomes (CO)

At the end of the course student will be able

CO1	quantify and categorize solid wastes for any region
CO2	understand the various functional elements in solid waste management
CO3	analyse the collection route and collection system
CO4	select suitable waste processing technologies
CO5	design a suitable sanitary landfill for disposal of solid waste

CEPE24 MODELS FOR AIR AND WATER QUALITY

Course Code	**:**	CEPE24
Course Title	**:**	**Models for Air and Water Quality**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC17
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To provide an understanding of mass balance approach for the prediction of air and water quality
CLO2	To study the transport phenomena of contaminants in surface water
CLO3	To learn mathematical model for transport of contaminants in river and estuaries
CLO4	To brief the models for lakes, growth and decay of microorganisms
CLO5	To give an idea of micrometeorological processes and its role in the transport of air pollutants

Course Content

Introduction to mathematical models – Modeling approaches to water quality – Classification of models;

Conservation of mass – Mass balance – Steady state system – Time variable response systems;

Mathematical models for water quality – Mass transport mechanisms – Model development- calibration and verification – Model limitations; DO and BOD models for streams: Source and sinks of dissolved oxygen – Streeter Phelps model – Oxygen sag curve –deoxygenation and reaeration coefficients – Benthal oxygen demand;

Models for estuary -Water quality distribution in estuaries –BOD and DO models; Models for Lakes: Eutrophication- steady and unsteady state models- Thermal stratification; Models for microorganisms – Growth and Decay;

Air quality models – Micrometeorological processes – Wind rose and stability classes – Gaussian dispersion model – Line source models – Indoor air quality model.

References

1.	Chapra and Steven C., Surface Water Quality Modelling, Waveland press, Inc., 2008.
2.	Gilbert M. Masters, Introduction to Environmental Engineering and Science, 3rd Edition, Pearson Education Limited, 2013.
3.	Davis M. L. and Cornwell D. A., Introduction to Environmental Engineering, Tata McGraw Hill Education Pvt. Ltd,. New Delhi, 2010.

Course Outcomes (CO)

At the end of the course student will be able

CO1	apply mass balance concept for air and water quality prediction
CO2	develop mathematical models for water quality based on transport mechanisms
CO3	predict the quality of water in river and estuaries using specific models
CO4	Evaluate eutrophication potential of lakes and bacterial growth kinetics
CO5	estimate the air pollutant concentration using dispersion models

CEPE25 HAZARDOUS WASTE MANAGEMENT

Course Code	**:**	CEPE25
Course Title	**:**	**Hazardous Waste Management**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC17
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To study the significance of hazardous waste management
CLO2	To learn hazardous waste minimisation practices
CLO3	To familiarize the environmental and health effects of electronic wastes (e-waste)
CLO4	To describe the importance of biomedical waste management
CLO5	To know the rules and regulations governing Hazardous, Biomedical and e-waste management

Course Content

Hazardous Waste: Sources – Characteristics - Classification - Impacts on human health and Environment - Environmental Regulations - Waste Minimization - Resource recovery - Storage - Transportation – Treatment - Landfill disposal;

E-waste: Composition – Characteristics – Environmental and Health implications – Storage - On-site Handling - Recycling - Extended producer responsibility (EPR) - Treatment and Disposal;

Biomedical waste: Source – Classifications – Health Hazards – Waste collection - Segregation - Labelling – Handling – Onsite/off site transportation – Treatment - Disposal;

Status of waste management - Rules and regulations governing waste management.

References

1	Michael D. LaGrega, Phillip L. Buckingham, Jeffrey C. Evans “Hazardous Waste Management” Waveland Press, 2010
2	John Pichtel, Waste Management Practices: Municipal, Hazardous, And Industrial, CRC press, 2014
3	Daniel A. Vallero, Deepak Kumar Yadav, Pardeep Singh, Pradeep Kumar (Eds) “Hazardous Waste Management: An Overview of Advanced and Cost-Effective Solutions” Elsevier Science, 2021
4	CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2016.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	identify and manage different types of hazardous wastes
CO2	select suitable waste minimization and resource recovery techniques for hazardous waste management
CO3	understand the environmental regulations and policies related to hazardous waste management
CO4	provide awareness for promoting sustainable e- waste management practices in local communities
CO5	suggest suitable disposal method for biomedical waste

CEPE26 INDOOR AIR QUALITY

Course Code	**:**	CEPE26
Course Title	**:**	**Indoor Environmental Quality**
Type of Course	**:**	PE
Prerequisites	**:**	
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To know the various sources of indoor air pollution and transport behaviour of pollutants
CLO2	To gain proficiency in sampling and analysis for indoor air pollution
CLO3	To familiarize the indoor air quality models
CLO4	To learn the properties of indoor aerosols and gases
CLO5	To study various indoor air pollution control methods

Course Content

Indoor air pollution: Sources – Effects – Sick building Syndrome - Sampling and analysis methods – Indoor air quality guidelines and standards - Simple mass balance models - Concepts of half-lives and residence times;

Indoor aerosols: Chemical and physical properties – Aerosol formation – Coagulation – Deposition – Gas-particle partitioning – Chemical kinetics – Chemical reactions in indoor air – Reactions on surfaces – Bioaerosol/biological particles in indoor atmosphere – Human exposure – Models for human exposure- Time-activity information – Risk assessment; Indoor air pollution control methods- CONTAM software.

References

1	R.M. Harrison, and R.E. Hester, Indoor Air Pollution: Issues in Environmental Science & Technology. RSC Press, 2019.
2	John D. pengler, John F. McCarthy, and Jonathan M. Same, Indoor Air Quality Handbook. McGraw Hill, 2000.
3	P Pluschke, H Schleibinger, Indoor Air Pollution. Springer-Verlag GmbH Germany 2018.
	Thad Godish, Indoor Air Pollution Control, CRC Press, 2017.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	identify and analyze the sources and types of indoor air pollutants and assess their impacts on indoor air quality
CO2	measure the indoor air pollution using relevant instrumentation
CO3	apply simple mass balance models to predict pollutant concentrations in indoor environments
CO4	evaluate the human exposure to indoor air pollutants using mathematical models
CO5	develop and recommend effective indoor air pollution control methods and strategies

CEPE27 HEALTH SAFETY AND ENVIRONMENT

Course Code	**:**	CEPE27
Course Title	**:**	**Health Safety and Environment**
Type of Course	**:**	PE

Prerequisites	**:**	CEPC17
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To study the basics of environmental health, occupational safety, and industrial hygiene
CLO2	To know the major environmental health hazards in work place
CLO3	To learn the regulatory framework and policies governing health and safety
CLO4	To familiarize the skills in risk assessment and management
CLO5	To learn the concepts of air and water quality management

Course Content

Regulations for Health, Safety and Environment – Introduction to occupational safety and health (OSH) – OSH regulations and law in India – Technical standards - Codes and guidelines on OHS – National and International standards of personal protective equipment and fire protection – Health and safety at work place – Hazards and risk assessments – Waste management – Fire protection and prevention – Principles of chemical safety – Radiation safety and bio safety – Emergency preparedness – Environment management and pollution control.

References

1	IS codes: IS 5903, IS 807, IS 2760, IS 14469, IS 13367-1, IS 5324, IS 7167, IS 7155, IS1800, IS 3521.
2	Handbook of Occupational Health and Safety, NIC, Chicago, 1982.
3	Encyclopedia of Occupational Health and Safety, Vol. I and II. International Labour Organisation, Geneva, 1985.
4	McCornick, E.J. and Sanders, M.S., Human Factors in Engineering and Design, Tata McGraw Hill, 1982.
5	Accident Preventional Manual, NSC Chicago, 1982. Henrich, H.W., Industrial Accident Prevention, McGraw Hill, 1980.
6	Less, F.P., Loss Prevention in Process Industries, Butterworth, New Delhi, 1986

Course Outcomes (CO)

At the end of the course student will be able to

CO1	identify and describe various environmental and occupational hazards
CO2	apply relevant health and safety regulations
CO3	implement strategies for managing and mitigating risks
CO4	suggest effective environmental, health, and safety audit programs
CO5	develop effective environmental pollution mitigation plans

STREAM III: GEOTECHNICAL ENGINEERING

CEPE30 ADVANCED FOUNDATION ENGINEERING

Course Code	**:**	CEPE30
Course Title	**:**	**Advanced Foundation Engineering**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC20
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To apply methods to design cantilever and anchored sheet pile walls in granular and cohesive soils.
CLO2	To design cellular cofferdams using TVA and Cumming's methods and understand their applications.
CLO3	To analyze types of caissons and determine necessary parameters for well foundation design
CLO4	To apply design criteria and IS code practices for foundations of impact and reciprocating machines.
CLO5	To conduct stability analysis for earth dam slopes under different conditions using established methods.

Course Content

Sheet pile structures - cantilever sheet pile walls in granular and cohesive soils - Anchored bulk heads - Free earth support and fixed earth support methods - Anchors.

Cofferdams - types - cellular cofferdam - uses - Design by TVA and Cumming's method.

Well foundations - Types of caissons - Analysis of well foundations - determination of scourdepth - staining thickness - well sinking.

Foundations subjected to vibrations - elements of vibrations - Free, damped, free and forced vibrations - Design criteria - Pauw's analogy - IS Code of practice for impact and reciprocating machines.

Foundation drainage and water proofing - Dewatering well points system, sand drains. Foundations in expansive soils - Mechanism - factors influencing swelling - Use of Geosynthetics.

Stability analysis of slopes - infinite slopes in sand and clays - finite slope - Swedish circle - stability of earth dam slope during steady and sudden draw down - friction circle method - Taylor's stability number. Sheet pile structures - Anchored bulk heads

References

1.	Bowles, J.E., Foundation Analysis and Design, McGraw Hill., 1996 (fifth edition)

2.	Braja M. Das, Principles of Foundation Engineering, Thomas Asia Pvt. Ltd., Singapore, 2005 (sixth edition)
3.	Shamsher Prakash, Soil Dynamics, McGraw - Hill Book Company 1985
4.	Tomlinson M.J., Pile design and construction Practice, Chapman and Hall Publication, 1994 (fifth edition)

Course Outcomes (CO)

At the end of the course student will be able

CO1	Design cantilever and anchored sheet pile walls in various soil types using free and fixed earth support methods.
CO2	Understand types and uses of cofferdams, and design cellular cofferdams using TVA and Cumming's methods.
CO3	Analyze well foundations, determine scour depth, and design well sinking and staining thickness
CO4	Design foundations for machines subjected to vibrations, applying vibration theory and IS code practices.
CO5	Perform stability analysis for infinite and finite slopes using methods like Swedish circle, friction circle, and Taylor's stability number.

CEPE31 GEOTECHNICAL EARTHQUAKE ENGINEERING

Course Code	**:**	CEPE31
Course Title	**:**	**Geotechnical Earthquake Engineering**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC20
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand seismic hazards and the principles of mitigation
CLO2	To analyze wave propagation in unbounded and layered media
CLO3	To evaluate dynamic soil properties and their impact on ground response
CLO4	To assess liquefaction hazards and their effects on structures
CLO5	To explain how seismic resistant design of foundation will be done and also to conduct seismic site investigations and interpret case studies

Course Content

Introduction- Seismic Hazards- Mitigation of Seismic Hazards- Seismology and earthquakes – Seismic hazard analysis

Wave propagation in unbounded medium- in semi-infinite bodies- in layered soils and attenuation of stress waves- Dynamic soil properties- Ground response analysis- Effect of local site conditions on ground motion

Seismic site investigations – Selected Case Studies - Evaluation of Dynamic soil properties – Codal Provisions-Strong ground motion -Design Ground Motion - Developing Design Ground Motion- Codal recommendations

Earthquake Resistant Design of foundation of buildings - Design considerations - Earthquake Response of slopes- Evaluation of slope stability

Liquefaction- Evaluation of liquefaction hazards- Effects of liquefaction- Case studies- Liquefaction Resistance- Codal recommendations.

Risk mapping - Hazard assessment – Mitigation measures - Seismic microzonation and its importance

References

1.	Kameswara Rao, N.S.V., Dynamics soil tests and applications, Wheeler Publishing - New Delhi, 2000.
2.	Krammer S.L., Geotechnical Earthquake Engineering, Prentice Hall, International Series, Pearson Education (Singapore) Pvt. Ltd., 2004.
3.	Kameswara Rao, Vibration Analysis and Foundation Dynamics, Wheeler
4.	Robert W. Day, Geotechnical Earthquake Engineering Handbook, McGraw
5.	Geotechnical Earthquake Engineering, NPTEL Video course. http://nptel.ac.in/courses/105101134/

Course Outcomes (CO)

At the end of the course student will be able

CO1	Ability to perform seismic hazard analysis and mitigation strategies
CO2	Competence in analyzing wave propagation in different soil conditions
CO3	Proficiency in evaluating dynamic soil properties and ground response
CO4	Capability to assess and mitigate liquefaction hazards
CO5	Skill in applying codal provisions and conducting risk mapping and seismic microzonation

CEPE32 REINFORCED EARTH AND GEOTEXTILES

Course Code	**:**	CEPE32
Course Title	**:**	**Reinforced Earth and Geotextiles**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC20
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To provide students with a historical perspective and fundamental principles of reinforced earth.
CLO2	To introduce students to the composition, manufacture, properties, functions, and

	testing of geotextiles and other geosynthetics.
CLO3	To develop students' ability to analyze and interpret the behavior and performance of reinforced earth walls and other structures
CLO4	To guide students in the field application and testing of reinforced earth structures.
CLO5	To provide hands-on experience in designing retaining walls, embankments, and foundation beds.

Course Content

Historical background; Principles concepts and mechanism of reinforced earth; Design consideration for reinforced earth and reinforced soil structures - Strength of reinforced soils – stress transfer mechanism – mode of reinforcement action – types of reinforcing materials – strips, grids and geogrids, sheet reinforcement, nailing, anchors, composite reinforcement – construction - Application.

Geosynthetics – Geotextiles, geomembrane, geogrid, geonets, geocomposites. Geotextiles – their composition, manufacture, properties, functions, testing, and applications in reinforced earth structures;

Design of reinforced soil structures like retaining walls, embankments, foundation beds, etc.; Design for Separation, Filtration, Drainage, and Roadway Applications; Design for Landfill Liners and Barrier Applications; Case histories of applications.[KP1]

Reinforcing materials; Advantage of RE; Behaviour of Reinforced earth walls; Soil reinforcement interaction internal and external stability condition; Field application of RE; Randomly reinforced earth and analysis of reinforced soils; Testing of soil reinforcements; Development, fabrication, design, and applications of geotextiles, geogrids, geonets, and geomembranes.

Geosynthetic reinforced soil embankment – Bearing capacity analysis of footing resting on reinforced foundation soil – Geosynthetics in flexible pavements – Reinforced soil for supporting shallow foundation

References

1.	Clayton, C.R.I., Milititsky, J. and Woods, R.I., Earth Pressure and Earth Retaining Structures, Blackie Academic & Professional, 1993.
2.	Ingold, T, Reinforced Earth, Thomas Telford Ltd., 1985
3.	Jones, C.J.F.P, Earth Reinforcement and Soil Structures, Butterworth, 1985
4.	Koerner, R.M, Designing with Geosynthetics, Prentice Hall, 1993.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Students will understand the historical background and fundamental principles of reinforced earth and reinforced soil structures.
CO2	Students will be able to describe the stress transfer mechanisms and modes of reinforcement action.
CO3	Students will acquire detailed knowledge of geosynthetics, including geotextiles,

	geomembranes, geogrids, geonets, and geocomposites, and their applications.
CO4	Students will learn the field application techniques and testing methods for reinforced earth structures.
CO5	Students will be able to assess the behavior of reinforced earth walls and understand soil-reinforcement interactions under various stability conditions.

CEPE33 EARTH AND EARTH RETAINING STRUCTURES

Course Code	**:**	CEPE33
Course Title	**:**	**Earth and Earth Retaining Structures**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC20
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To evaluate stability of slopes under different drainage conditions using different methods including slope protection and quality control.
CLO2	To familiarise the classical theories used to quantify lateral earth pressure
CLO3	To design and analyse the rigid retaining structure under various external conditions.
CLO4	To design sheet pile walls for various soil conditions.
CLO5	To quantify the earth pressure on braced cuts, diaphragm walls and to design the reinforced earth structures.

Course Content

Slope – types of slope failure - Stability analysis of infinite and finite slopes - Limit Equilibrium method- Wedge analysis- Method of Slices - Friction circle method - Bishop's method- Janbu's method - Taylor stability charts- Field Instrumentation – In Situ measurement of pore pressures in slope-Slope protection measures

State of stress in retained soil mass – Mohr's circle for Active, passive and at rest cases – Earth pressure theories – Classical method – Rankine analysis, Coulomb analysis - Graphical techniques -Culmann's method – Rebhmann method – Limitations of earth pressure theories - Retaining structures – Selection of soil parameters.

Lateral earth pressure due to compaction, strain softening, wall flexibility, drainage, seismic forces and its influence. – Stability analysis of earthen dams- Stability analysis and design of gravity retaining wall with surcharge load, inclined backfill, with and without seismic loads.

Flexible retaining structure – Parts of sheet pile wall- Types of sheet piles - Analysis and design of cantilever and anchored sheet pile walls in cohesionless and cohesive soils – free earth support method – fixed earth support method.

Lateral pressure on sheeting in braced excavation- stability against piping and bottom

heaving – Design of Diaphragm walls – Analysis and design of reinforced earth structures - Soil anchors – Soil pinning – Basic design concepts - Slurry Supported Trenches.

References

1.	Clayton, Milititsky and Woods, Earth Pressure and Earth-Retaining Structures, Taylor and Francis, 1996
2.	Das, B.M., Principles of Geotechnical Engineering, Eighth Edition, Cengage Learning, 2014.
3.	Militisky, J. and Woods, R., Earth and Earth retaining structures, Third Edition, CRC Press Taylor & Francis Group, 2013.
4.	Muni Budhu, Soil Mechanics and Foundation, John Wiley and Sons, INC 2007.
5.	Mandal, J.N., Reinforced Soil and Geotextiles, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 1993.

Course Outcomes (CO)

At the end of the course student will be able

CO1	To understand the various approaches for analysing infinite and finite slopes.
CO2	To conceive the estimation of active and passive earth pressure using different earth pressure theory including graphical methods .
CO3	To design the rigid retaining wall and stability analysis for all kinds of drainage conditions.
CO4	To design the sheet pile wall structurally to retain any type of soil and drainage conditions.
CO5	To apply the knowledge on lateral earth pressure behind and around excavation to analyse and design braced excavations, slurry supported excavations and underground utilities.

CEPE34 MARINE FOUNDATION ENGINEERING

Course Code	**:**	CEPE34
Course Title	**:**	**Marine Foundation Engineering**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC20
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To emphasize the importance of offshore soil investigations for offshore structures
CLO2	To analysis the response of foundations of gravity structures under offshore environmental loading
CLO3	To analysis the foundation response of jacket platforms under static and dynamic loading
CLO4	To analysis the foundation response of jack-up platforms under static and dynamic

	loading
CLO5	To provide a suitable foundation system for mooring structures and offshore pipe lines

Course Content

Offshore soil investigation: General characteristics of offshore soil exploration – sampling using free corer, gravity corer, tethered systems and manned submersibles – deep penetration sampling using wire line techniques – sampling disturbances – mechanical and environmental - In-situ determination of strength of submarine soils – penetrometer, piezocone, vane and pressure meter techniques – penetration tests from tethered submersible platforms, manned submersibles and using wire line techniques - classification of marine soils – relative distribution of marine soils in the different marine regions – general characteristics of marine deposits in some specific locations and in the Indian sub continent.

Foundations for gravity structures: Types of gravity structures – Installation techniques – movement of gravity structures – settlement of soil beneath gravity structures – stress distribution beneath gravity structures – stability of gravity structures under static and cyclic loads.

Foundation for jacket type structures: Types – installation techniques – design considerations – axial and lateral load capacity of piles – lateral load deformation behaviour of piles – calculation of bearing capacity of piles- design of piles subjected to lateral loads – Reese-Matlock method and p-y curves method

Foundations for jack up platforms: Types of jack up platforms – piles and mat supported – spud cans – different types – installation techniques – techniques for removal of jack ups – stability of jack up platforms –determination of penetration of supports – stability under lateral loads –stability under static and cyclic load effects.

Sea bed anchors, submarine pipe lines: General introduction to sea bed anchors, moorings, submarine pipe line etc., - general design considerations (brief outline only) – geotechnical aspects in the design and installation of sea bed anchors, moorings, submarine pipelines etc

References

1.	Arous, D.A. (Ed.), Offshore Site Investigation, Graham Trotman
2.	Chaney, R.C and Demars, K.R , Strength Testing of Marine Sediments – Laboratory and In-situ Measurements, ASTM, STP-883
3.	George P. and Wood D., Offshore Soil Mechanics, Cambridge University Press.
4.	Le Tirant, Sea Bed Reconnaissance and offshore Soil Mechanics for the Installation of Petroleum Structures, Gulf Publ. Company
5.	Poulos, H.G and Davis, E.H, Pile Foundation Analysis Design, John Wiley, New York

Course Outcomes (CO)

At the end of the course student will be able

CO1	Recommend suitable offshore investigation techniques for the proposed project and

	able to provide appropriate soil design parameters
CO2	Perform foundation analysis for gravity structures kind of offshore structures
CO3	Perform foundation analysis for jacket kind of offshore structures
CO4	Perform foundation analysis for jack-up kind of offshore structures
CO5	Analysis suitable anchor system for mooring structures and able to provide foundation system for offshore pipeline.

CEPE35 GROUND IMPROVEMENT TECHNIQUES

Course Code	**:**	CEPE35
Course Title	**:**	**Ground Improvement Techniques**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC20
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the importance of ground improvement techniques
CLO2	To study the concept of dewatering techniques and preloading techniques
CLO3	To discuss the in-situ compaction method and replacement techniques
CLO4	To learn the concept of role reinforcement in ground improvement techniques
CLO5	To familiarize students with grouting techniques and stabilization of problematic soil

Course Content

Role of ground improvement in foundation engineering – Methods of ground improvement – Geotechnical problems in alluvial, lateritic and black cotton soils – Selection of suitable ground improvement techniques based on soil conditions.

Dewatering Techniques – Well points – Vacuum and electroosmotic methods – Consolidation– Preloading with sand drains, and fabric drains.

In-situ densification of cohesionless soils – Shallow and deep compaction – Dynamic compaction – vibro flotation and sand compaction piles, stabilization of soft clay ground using stone columns and Lime piles - Installation techniques – Relative merits of above methods and their limitations.

Concept of reinforcement – Types of reinforcement material – Reinforced earth wall – Mechanism – Simple design – Applications of reinforced earth; Functions of Geotextiles in filtration, drainage, separation, road works and containment applications.

Types of grouts – Grouting equipments and machinery – Injection methods – Grout monitoring – Stabilization with cement, lime and chemicals – Stabilization of expansive soil.

References

1	Hausmann, M. R., Engineering Principles of Ground Modification, McGraw – Hill International Editions, 1990
2	Han, J., Principles and Practice of Ground Improvement, John Wiley and Sons, New Jersey, Canada 2015.
3	Purushothama Raj. P, “Ground Improvement Techniques”, Lakshmi Publications, 2nd Edition, 2016.
4	Mittal. S, “An Introduction to Ground Improvement Engineering”, Medtech Publisher, First Edition, 2013.
5	Jones C.J.F.P. “Earth Reinforcement and Soil Structure”, Thomas Telford Publishing, 1996.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	To familiarize students with ground improvement techniques and their practical applications
CO2	To apply various dewatering and consolidation techniques for different soil conditions
CO3	To get exposed to and assess in-situ densification and stabilization techniques
CO4	To understand reinforcement concepts and materials, including the mechanisms and applications of reinforced earth walls.
CO5	To become familiar with grouting techniques and the stabilization of problematic soils.

CEPE36 ROCK MECHANICS

Course Code	**:**	CEPE36
Course Title	**:**	**Rock Mechanics**
Type of Course	**:**	PE
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	Understand the basic principles and scope of rock mechanics and its geological aspects.
CLO2	Learn the physical and mechanical properties of rocks and the methods for testing these properties in the laboratory and field.
CLO3	Classify rock masses and understand their behavior, stability, and failure criteria.
CLO4	Gain knowledge of various tunneling techniques and the support systems used in tunnel construction
CLO5	Learn the importance of stress analysis and instrumentation in tunnels and review significant case studies to apply theoretical knowledge to practical scenarios.

Course Content

Importance of rock mechanics - Historical development and applications - Geological Formation and Classification of Rocks - Rock cycle and geological processes - Classification based on origin: igneous, sedimentary, and metamorphic - Basic properties of different rock types - Discontinuities in Rock - Types of discontinuities: joints, faults, folds - Importance of discontinuities in rock mechanics

Rock Properties - Laboratory Testing of Rocks - Sampling and preparation techniques - Common laboratory tests: uniaxial compression, Brazilian test, shear tests - Field Testing Methods.

Rock Mass Classification Systems - Overview of RMR and Q-system - Rock Mass Behavior and Failure Criteria - Introduction to Mohr-Coulomb and Hoek-Brown criteria - Stress-strain behavior and failure mechanisms - Slope Stability and Remedial Measures - Factors affecting slope stability - Methods for slope stability analysis - Common remedial measures for slope stabilization -Foundation Design - Rock bearing capacity.

Types and applications of tunnels - Historical development of tunneling techniques- Overview of drill and blast method - Basics of tunnel boring machines (TBMs) - Basics of tunnel boring machines (TBMs) - Tunnel Support Systems - Types of supports: rock bolts, shotcrete, steel sets - Principles of temporary and permanent support systems.

Stress Analysis Around Underground Excavations - Importance of stress analysis in tunnelling- Instrumentation in Tunnels - Common instruments: inclinometers, piezometers, strain gauges - Monitoring techniques and data interpretation - Case Studies - Overview of significant tunneling projects

References

1	Hudson J.A. and Harrison J.P., “Engineering Rock Mechanics – An Introduction to the principles”, Pergamon, 1997.
2	Goodman.R.E, “Introduction to rock mechanics”, John Willey and Sons, 1989.
3	Hook.E and Bray.J, “Rock slope Engineering, Institute of Mining and Metallurgy”, U.K. 1981.
4	Hook.E and Brown.E.T, “Underground Excavations in Rock”, Institute of Mining and Metallurgy, U.K. 1981.
5	Obvert.L and Duvall.W, “Rock Mechanics and the Design of structures in Rock”, John Wiley, 1967

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Demonstrate fundamental knowledge of rock mechanics and geological formations relevant to civil engineering projects.
CO2	Apply laboratory and field testing methods to determine the physical and mechanical properties of rocks.
CO3	Classify rock masses using basic systems and understand the factors affecting slope stability.

CO4	Explain various tunneling techniques and the principles of tunnel support systems.
CO5	Conduct basic stress analysis and understand the role of instrumentation in ensuring the safety and stability of tunneling projects.

CEPE37 GEOENVIRONMENTAL ENGINEERING

Course Code	**:**	CEPE37
Course Title	**:**	**Geoenvironmental Engineering**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC20
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To identify the sources of soil contamination and its impact on the geoenvironment.
CLO2	To familiarize with the retention and flow behavior of contaminants in soil.
CLO3	To realize the significance of sampling techniques in geoenvironmental characterization.
CLO4	To understand the state-of-the-art methodologies for soil decontamination and containment.
CLO5	To realize the importance in implementation of laws and regulation in the geoenvironmental domain.

Course Content

Role of Geoenvironmental Engineering - Basic concepts related to soil pollution – Sources of pollutants - waste disposal methods – Types and impact of contaminants – soil - waste interaction – Design of Engineered Landfill- types.

Physical and physio-chemical mechanisms- diffuse double layer- Sorption characteristics - Adsorption measurements (Batch and Column tests) - Isotherms – Retention behavior - Contaminant transport- saturated, unsaturated and coupled flow.

Site investigation - Soil sampling – Soil properties - Mineralogical characterization of soil and waste - pore size distribution characteristics- swell and shrink cycle - Non-destructive techniques - electromagnetic, thermal imagery and seismic techniques.

Soil remediation - need and approach, Techniques – Basis of selection of techniques - soil washing - permeable reactive barriers, solidification- vacuum extraction, electro-kinetic remediation with mechanisms, thermal desorption- soil fracturing- Bioremediation – microbial transformations - phytoremediation.

Case studies on polluted sites and issues related to the environment - Containment systems and basic principles – carbon dioxide sequestration, Grout curtains, Ground freezing, Compacted soil liners, Geosynthetic clay liners - Environmental laws and

regulations.

References

1	Fang H.Y, Ronald.C.Chaney, "Introduction to Environmental Geotechnology (2nd Edition)", CRC Press, 2016.
2	Acar, Y.B. and Daniel, D.E., "Geoenvironmental 2000: Characterization, Containment, Remediation & Performance in Environmental Geotechnics, ASCE, NY.
3	Reddi L.N. and Inyang, H. I., "Geoenvironmental Engineering, Principles and Applications" Marcel Dekker Inc. New York, 2000.
4	Hari D. Sharma and Krishna R. Reddy, Geo-Environmental Engineering – John Wiley and Sons, INC, USA, 2004.
5	Yong, R. N., "Geoenvironmental Engineering, Contaminated Soils, Pollutant Fate, and Mitigation" CRC Press, New York, 2001.
6	Daniel B.E, Geotechnical Practice for waste disposal, Chapman & Hall, London, 1993.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	To understand the various causes and how to safely dispose the waste through different containment process
CO2	To understand the various mechanism of transport of contaminants into subsurface
CO3	To understand the concept of soil and waste characterization techniques.
CO4	To understand how to decontaminate the site to reuse the site for human settlement.
CO5	To understand the consequences of soil waste interaction and its modifications.

CEPE38 FUNDAMENTALS OF GEOSYNTHETIC ENGINEERING

Course Code	**:**	CEPE38
Course Title	**:**	**Fundamentals Of Geosynthetic Engineering**
Type of Course	**:**	PE
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To describe the raw materials, manufacturing processes, and properties of geosynthetics.
CLO2	To apply geosynthetics in retaining walls, embankments, roads, railways, and other structures for stabilization and containment.
CLO3	To implement best practices for geosynthetic installation, protection, and damage assessment.
CLO4	To follow detailed procedures for using geosynthetics in retaining walls, embankments, roads, and tunnels.

CLO5	To conduct economic evaluations, cost analysis, and follow standards and codes of practice for geosynthetics.

Course Content

General description: Introduction - Geosynthetics - Basic characteristics - Raw materials - Manufacturing processes - Geosynthetic engineering - Functions and selection.- Physical properties - Mechanical properties -Hydraulic properties - Endurance and degradation properties - Test and allowable properties -Description of geosynthetics.

Application areas: Introduction - Retaining walls - Embankments - Shallow foundations - Roads - Unpaved roads - Paved roads - Railway tracks - Filters and drains - Slopes – Erosion control - Stabilization - Containment facilities - Landfills - Ponds, reservoirs, and canals – Earth dams -Tunnels - Installation survivability requirements.

Application guidelines: Introduction - General guidelines - Care and consideration - Geosynthetic selection - Identification and inspection - Sampling and test methods – Protection before installation - Site preparation - Geosynthetic installation - Joints/seams - Cutting of geosynthetics - Protection during construction and service life - Damage assessment and correction - Anchorage - Prestressing - Maintenance - Certification - Handling the refuse of geosynthetics.

Specific guidelines: Retaining walls - Embankments - Shallow foundations - Unpaved roads - Paved roads - Railway tracks - Filters and drains - Slopes – erosion control - Slopes – stabilization - Containment facilities – Tunnels

Quality and field performance monitoring: Introduction - Concepts of quality and its evaluation - Field performance monitoring: Economic evaluation - Concepts of cost analysis: Selected case studies: Standards and codes of practice.

References

1	Ingold, T, Reinforced Earth, Thomas Telford Ltd., 1985
2	Jones, C.J.F.P, Earth Reinforcement and Soil Structures, Butterworth, 1985
3	Koerner, R.M, Designing with Geosynthetics, Prentice Hall, 1993.
4	Robert M. Koerner, Designing with Geosynthetics, fifth edition 1933
5	Clayton, C.R.I., Milititsky, J. and Woods, R.I., Earth Pressure and Earth Retaining Structures, Blackie Academic & Professional, 1993.
6	Han, J., Principles and Practice of Ground Improvement, John Wiley and Sons, New Jersey, Canada 2015

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Understand the basic characteristics and functions of geosynthetics.
CO2	Identify the various application areas of geosynthetics in engineering projects.
CO3	Follow guidelines for the selection, installation, and maintenance of geosynthetics.
CO4	Apply specific guidelines for the use of geosynthetics in various structures.
CO5	Evaluate the quality and field performance of geosynthetics

CEPE39 ENGINEERING GEOLOGY

Course Code	**:**	CEPE38
Course Title	**:**	**Engineering Geology**
Type of Course	**:**	PE
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	Identify and describe the physical properties of minerals, including hardness, color, streak, and luster, and their relevance in mineral identification
CLO2	Classify rocks into igneous, sedimentary, and metamorphic types based on their physical properties and geological characteristics.
CLO3	Identify and characterize geological structures such as folds, faults, unconformities, and joints in geological formations.
CLO4	Summarize the causes, effects, and impact of earthquakes and landslides on civil engineering projects and infrastructure.
CLO5	Evaluate and select suitable dam sites by analyzing geological factors and considerations to ensure structural stability and project success.

Course Content

Introduction: Definition of Geology, Engineering Geology. Importance of geology from Civil Engineering point of view. Importance of physical geology, petrology and structural geology. Mineralogy: Importance of study of minerals, Different methods of study of minerals. Role of study of physical properties of minerals in the identification of minerals. Study of physical properties of common rock forming minerals and Economic minerals.

Petrology: Geological classification of rocks into igneous, Sedimentary and metamorphic rocks. Dykes and sills, common structures and textures of igneous, Sedimentary and metamorphic rocks, their distinguishing features. Megascopic study of different rocks.

Structural Geology: Out crop, strike and dip study of common geological structures associating with the rocks such as folds, faults, unconformities, and joints - their important types.

Earthquakes: Earthquakes, their causes and effects, shield areas and seismic belts. Seismic waves, Richter scale, precautions to be taken for building construction in seismic areas. Landslides, their causes and effect, measures to be taken to prevent their occurrence.

Geology of Dams & Reservoirs: Geological Considerations in the selection of a dam site. Analysis of previous dam failures. Factors contributing in the success of a reservoir.

References

1	N. Chennakesavulu, Engineering Geology, 3rd Edition, Laxmi Publications Pvt. Ltd, 2018.
2	P.C. Varghese, Engineering Geology for Civil Engineers, 3rd Edition, PHI Learning & private Limited, 2012.
3	K.V.G.K. Gokhale, Principles of Engineering Geology, 3rd Edition, B.S publications, 2010.
4	Rahm, P.H (1985). Engineering Geology. An Environmental Approach, Elsevier, XI, pp.1-589.
5	Lama, R.D., and Vutukari, S. (1978). Mechanical Properties of Rocks. Trans Tech Pub. II.pp.28-314.
6	Bell, F.G. (2007). Engineering Geology, pp.1-551, Gangopadhyay, S. (2013). Engineering Geology, Oxford University Press, pp.1-549.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Illustrate various properties of the minerals.
CO2	Classify the rocks based on their physical properties.
CO3	Identify folds, faults, unconformities, and joints associated with geological structures.
CO4	Summarize the causes and effects of earthquakes and landslides.
CO5	Select dam site based on the geological considerations

STREAM IV: GEOSPATIAL TECHNIQUES

CEPE40 GEODETIC SURVEYING

Course Code	**:**	CEPE40
Course Title	**:**	**Geodetic Surveying**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC13
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To know the significance of geodetic surveying in field measurements in terms of utility and precision of data collection
CLO2	To learn on the principles of Triangulation, Trignometic leveling and their procedures
CLO3	To get introduced to the concept of curves and curve setting
CLO4	To know in detail different types of errors and their adjustments
CLO5	To get introduced to the coordinate systems, reference plans and projections

Course Content

Curve setting – Horizontal curves - Elements of simple and compound curves – Methods of setting out – Reverse curve – Transition curve – Elements of cubic parabola, true spiral and cubic spiral

Triangulation – different networks – orders and accuracies – intervisibility and height of stations – signals and towers – Baseline measurement – instruments and accessories – tape corrections – extension of baseline – satellite stations – Reduction to centre.

Trignometrical levelling – Plane Observations – Geodetic observations – Corrections for refraction, curvature, axis signal – Reciprocal observations

Errors – Types of errors – Theory of least squares – weighted observations – most probable value – computations of indirectly observed quantities – method of normal equations – conditioned quantities, method of correlates, method of differences – adjustment of simple triangle and quadrilateral network without central station.

Reference Surfaces – Datums – Geoids – Coordinate systems – Map Projections – Transformation – Geodesy - Types

References

1	Duggal, S.K. Surveying Vol. I and II, Tata McGraw Hill, 2019.
2	Punmia, B.C. Surveying Vol.I and II, Laxmi Publications, 2016 (Vol I), 2023 (Vol II).
3	Punmia, B.C. Higher Surveying Vol III, Laxmi Publications, 2022.
4	Arora, K. R. Surveying Vol. I and II, Standard Book House, 2019
5	Satheesh Gopi. Advanced Surveying, Pearson Education, 2017.
6	Satheesh Gopi. The Global Positioning System, Tata McGraw, 2017.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Select the correct, best suited curve and set the curve on the road
CO2	Apply geodetic methods such as Triangulation in baseline measurements and large area estimation
CO3	Apply Trigonometric leveling in estimation of elevation in plane survey and geodetic observation
CO4	Identify the errors present in the field observation and to adjust the errors using suitable methods
CO5	Demonstrate the principles of the earth surface, its projections and different coordinates involved in map making

CEPE41 ADVANCED SURVEYING TECHNIQUES

Course Code	**:**	CEPE41
Course Title	**:**	**Advanced Surveying Techniques**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC13
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To know the significance of advanced surveying in field measurements in terms of utility and precision of data collection
CLO2	To learn on the principles of Electromagnetic distance measurement, Total Station and their accuracy
CLO3	To get introduced to the concept of photogrammetry in preliminary identification and map making
CLO4	To know in detail the concept of remote sensing in identification of land features from space and to get introduced to different data acquisition techniques like LIDAR, RADAR
CLO5	To get introduced to the field of geodesy, coordinate systems, Map projections, GPS, its working principle, data collection, data processing and analysis

Course Content

Introduction to Advanced Surveying Techniques - Electro magnetic distance measurement (EDM) – Principle of EDM Carrier waves – Types of EDM instruments – Distomat – Total Station – Principle – procedure & surveying using Total Station – precise leveling - micro-optic theodolite.

Remote sensing – concepts – Idealized remote sensing system – characteristics – Types of remote sensing system – Remote sensing from space – Data interpretation – application of remote sensing – LIDAR – RADAR - SONAR.

Geodesy – Figure of earth – Classification – Earth surface - Geodetic reference surfaces - Coordinate systems – Geodetic datums and elements – Map – Scale of map – projection – UTM – Map projection of India – Space Geodesy.

GPS Basics – system overview – working principle of GPS – Satellite ranging –calculating position – Ranging errors and its correction – GPS surveying Methods – static, Rapid static, DGPS and Kinematic methods – visibility diagram – GAGAN - GNSS.

Photogrammetry – Terrestrial and Aerial Photogrammetry – Digital Photogrammetry - Drone Technology – Applications of advanced Surveying Techniques in Civil Engineering – Case studies

References

1.	Duggal, S.K. Surveying Vol. I and II, Tata McGraw Hill, 2019.

2.	Punmia, B.C. Surveying Vol.I and II, Laxmi Publications, 2016 (Vol I), 2023 (Vol II).
3.	Punmia, B.C. Higher Surveying Vol III, Laxmi Publications, 2022.
4.	Arora, K. R. Surveying Vol. I and II, Standard Book House, 2019.
5.	Satheesh Gopi. Advanced Surveying, Pearson Education, 2017.
6.	Satheesh Gopi. The Global Positioning System, Tata McGraw, 2017.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Understand the different Advanced Surveying Techniques such as use of EDMs, Total Station, Digital Level in accurate measurement and Mapping Select the advanced technique which is best suited for a work
CO2	Gain knowledge of use of Remote Sensing in Land use survey by understanding its principle and data interpretation keys
CO3	Demonstrate the principles of the earth surface, its projections and different coordinates involved in map making
CO4	Understand the working principle of GPS and different methods of measurement
CO5	Understand the importance and application of different advanced Surveying techniques in different areas of Civil Engineering through different case studies

CEPE42 GEODESY

Course Code	**:**	CEPE42
Course Title	**:**	**Geodesy**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC13
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To know the significance of Geodesy in understanding earth parameters
CLO2	To learn on the different reference surfaces and the datum with respect to measurements on horizontal and vertical plane
CLO3	To get introduced to the concept of map projection
CLO4	To know in detail on Field astronomy, estimation of different coordinate systems used to define position of a point
CLO5	To get introduced to the field of different space geodetic techniques

Course Content

Geodesy – definition – Classification – Branches of Geodesy – History – Earth's shape and earth parameters – Geodetic reference surfaces – Spheriod, ellipsoid, Geoid – Relationships between surfaces – Global and Local geodetic datums

Geometric geodesy – Geodetic systems – World Geodetic System – Everest ellipsoid of India – Ellipsoid of revolution – US DoD WGS systems and recent datums – ITRS and ITRF

– IGS systems – Coordinate systems – Geodetic, Geocentric latitude and Reduced latitude – Cartesian rectangular system – Coordinate conversions – Datum transformation - Geodetic datum elements – height systems

Map projection – Definition – History – geometry of earth surface – Classification of Map projection – Conical projection – cylindrical projection – azimuthal projection – Ideal map projection – Mercator projection – Traverse Mercator projection – UTM – Grids – Lamberts grid of India

Field astronomy – Astronomical terms – Terrestrial latitude and longitude – Horizon – Hour angle – Right ascension – astronomical triangle – azimuth – Coordinates systems – earth's orbital motion round the sun – Measurement of time – Sidereal time – Solar Apparent time – Mean solar time – Time conversions – Determination of latitude

Space Geodesy – Reference systems – Doppler satellite surveying – NAVSTAR GPS – GNNS - Very Long Base Interferometry – space VLBI – SLR – LLR – Application – Satellite Altimetry

References

1	Duggal, S.K. Surveying Vol. I and II, Tata McGraw Hill, 2019.
2	Punmia, B.C. Surveying Vol.I and II, Laxmi Publications, 2016 (Vol I), 2023 (Vol II).
3	Punmia, B.C. Higher Surveying Vol III, Laxmi Publications, 2022.
4	Arora, K. R. Surveying Vol. I and II, Standard Book House, 2019.
5	Satheesh Gopi. Advanced Surveying, Pearson Education, 2017.
6	Satheesh Gopi. The Global Positioning System, Tata McGraw, 2017.

Course Outcomes (CO)

At the end of the course student the student is expected to

CO1	Understand the different difference branches of Geodesy, Earth Shape, Reference surfaces, datum and their relationships for estimation of horizontal and vertical control
CO2	Gain knowledge of global and local reference plans, coordinate systems for different countries and their utility in position mapping
CO3	Understand different map projections used with respect to location and county
CO4	Gain knowledge on Field astronomy and their importance in defining the position on coordinate system
CO5	Understand the importance of space geodesy in civil engineering applications

CEPE43 DISASTER MODELLING AND MANAGEMENT

Course Code	**:**	CEPE43
Course Title	**:**	**Disaster Modelling and Management**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC13
Contact Hours	**:**	36

Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To comprehend the definitions, types, and impacts of various natural and man-made disasters.
CLO2	To gain knowledge on model selection, simulation processes, and the principles and limitations of statistical modelling for hazard prediction.
CLO3	To study the disaster management cycle, including hazard identification, mitigation strategies, and risk reduction measures.
CLO4	To learn tools and techniques for effective emergency management, including early warning systems, communication strategies, and evacuation planning.
CLO5	To understand the role of information, communication, and geo-informatics technologies in disaster management and their applications in risk and vulnerability mapping.

Course Content

Introduction to Disaster - Definitions, Hazards, Exposure, Vulnerability, Risk – Types of disasters – Natural and Man-made - Earth quake, Liquefaction, Landslide, Flood, Dam break, Cyclone and Tsunami, Drought and Forest fire, Chemical, industrial and accidents.

Model selection -simulation of a specific process- modelling principles and assumptions, -limitations. Classification- factors causes hazards -evaluate relative importance- Multi-Criteria Decision Analysis (MCDM), Artificial Neural Network(ANN), Fuzzy logic, Artificial Intelligence (AI)

limitations in statistical modelling for hazard prediction -data-driven methods for hazard prediction - scientific and engineering principles underlying natural hazards - factors triggering hazards - Analyse the spatio-temporal evolution of hazards and hazard interactions.

Disaster Management Cycle - Hazard identification - Pre and Post-disaster activities - Search and rescue (SAR) vulnerability and risk assessment - Mitigation strategies and measures - risk reduction and Infrastructure - Soft computing tools in assessment of vulnerability and risk. - Risk reduction strategies - Structural and Non-Structural - Climate Change Adaptation.

Emergency Management Planning - Tools for risk reduction measures - early warning - Emergency exercises/training - Emergency communications systems - The Emergency Operation Plan (EOP) - Evacuation plans and training - Emergency personnel/contact lists - Role of Information, Communication and Geo-informatics Technologies in Disasters - Communication System, Wireless Communication, Bluetooth Wireless Technology, HAM Radio, GPS Application in Emergency Communication-UNOSAT's Humanitarian Rapid Mapping Service, Applications of Remote sensing and GIS in DMM-Case Studies and Application of DMM in Various Disasters - Risk and Vulnerability mapping for flood, landslide, drought, forest fire, Liquefaction and earthquake.

References

1	Etkin, D. Disaster Theory: An Interdisciplinary Approach to Concepts and Causes, Elsevier Science & Technology, 2015.
2	D. Hyndman and D. Hyndman, Natural hazards and disasters, Brooks/Cole, 2006.
3	Kolathayar and Sitharam, Earthquake hazard assessment: India and adjacent regions, CRC Press, 2018.
4	Durrani, Wang and Forbes, Geological disaster monitoring based on sensor networks, Springer, 20195.
5	Carter, W. N. Disaster Management: A Disaster Management Handbook, Asian Development Bank, Bangkok, 1991.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Ability to define and classify various natural and man-made disasters, understanding their causes and effects.
CO2	Proficiency in selecting appropriate modelling techniques for hazard prediction, considering scientific and engineering principles.
CO3	Competence in assessing vulnerability and risk, and applying structural and non-structural mitigation strategies to reduce disaster impacts.
CO4	Skills to create and execute comprehensive emergency management plans, including early warning systems, evacuation plans, and effective communication strategies.
CO5	Capability to apply remote sensing, GIS, and other technological tools for disaster risk and vulnerability mapping, and to analyse case studies for practical insights.

CEPE44 AI/ML& DL FOR REMOTE SENSING AND GIS

Course Code	**:**	CEPE44
Course Title	**:**	**AI/ML & DL For Remote Sensing And Gis**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC13
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the foundational concepts and history of Artificial Intelligence (AI) and Machine Learning (ML).
CLO2	To learn various machine learning techniques including supervised and unsupervised learning.
CLO3	To develop proficiency in implementing linear classification methods and optimizing models.
CLO4	To gain knowledge of deep learning principles and techniques including neural networks, CNNs, and RNNs.

CLO5	To apply AI/ML methods to solve practical problems in diverse application areas such as environmental monitoring and disaster management.

Course Content

Fundamentals of AI and history of AI- Agents and Environments, the concept of rationality- the nature of environments - structure of agents Well-posed learning problems, examples of machine learning applications, model selection and generalization, concept learning.

Linear Classification: Linear classifier, Logistic Regression, Decision Boundary- Regression and classification- Linear Classification: Linear classifier, Logistic Regression, Decision Boundary, Cost Function Optimization, Multi-class Classification, Bias and Variance

Supervised learning- support vector machines- random forest classifier – gradient boosting random forest– Gaussian processor- unsupervised learning – clusters– k- means- fuzzy concepts – possibilistic C-Means- training date sets- measures of accuracy: RMS, correlation coefficient, ROC- Inferential statistics - hypothesis testing – spectral divergence- spectral angle mapper – spectral correlation analysis.

Introduction to deep learning, logical computations with neurons, perceptron, backpropagation, historical trends, applications, and use-cases for industry- Training a deep neural network (DNN), hidden layers, activation functions, fine-tuning neural network hyper-parameters.Convolutional neural networks (CNNs): Introduction to CNNs- Back Propagation Algorithm- convolutional layer, filters, stacking, pooling layer, CNN architectures-Recurrent neural networks (RNNs): recurrent neurons, unrolling, input and output sequences, training RNNs, deep RNNs

Applications of AI/ML – Crop classification- Landslide mapping- flood mapping- glaciers monitoring- -forest fire mapping- Mineral Mapping-Land surface Temperature- potential groundwater zone mapping- Oil spill detection- soil erosion, soil salinity mapping, air quality Mapping.

References

1	Bratko, "Prolog: Programming for Artificial Intelligence", Fourth edition, Addison Wesley Educational Publishers Inc., 2011.
2	M. Tim Jones, "Artificial Intelligence: A Systems Approach (Computer Science)", Jones and Bartlett Publishers, Inc.; First Edition, 2008
3	Christopher Bishop, Pattern Recognition and Machine Learning, Springer
4	François Chollet "Deep Learning with Python," First Edition, Manning Publication
5	Sudharsan Ravichandran "Hands-On Deep Learning Algorithms with Python," First Edition, Packt Publishing

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Explain the fundamental principles and historical context of AI and ML.
CO2	Implement and evaluate various machine learning algorithms and techniques.

CO3	Develop and optimize linear classification models for regression and classification tasks.
CO4	Design, train, and fine-tune deep neural networks for complex problem-solving.
CO5	Apply AI/ML solutions to real-world challenges in areas like agriculture, environmental monitoring, and disaster response.

CEPE45 GEOMATICS IN WATER RESOURCES ENGINEERING

Course Code	**:**	CEPE45
Course Title	**:**	**Geomatics in Water Resources Engineering**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC13
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To gain a sound fundamental understanding of the GIS and remote sensing technologies
CLO2	To understand the basic principles underlying the GIS/model-based management of water resources and environment.
CLO3	To become familiar with the GIS-based analytical and problem-solving techniques for sustainable planning and management of water resources and environmental problems.
CLO4	Different types of remotely sensed images and data available for water resource applications.
CLO5	To gain knowledge on advanced applications of Geomatics in different applications of Water resources.

Course Content

Physics of remote sensing, electromagnetic radiation (EMR), Interaction of EMR with atmosphere, earth surface, soil, water and vegetation; Remote sensing platforms – Monitoring atmosphere, land and water resources - LANDSAT, SPOT, ERS, IKONOS and others, Indian Space Programme.

Satellite Data analysis - Visual interpretation – Digital image processing – Image preprocessing – Image enhancement – Image classification – Data Merging.

Definition – Basic components of GIS – Map projections and co-ordinate system – Spatial data structure: raster, vector – Spatial Relationship – Topology – Geodatabase models: hierarchical, network, relational, object oriented models – Integrated GIS database - common sources of error – Data quality: Macro, Micro and Usage level components - Meta data - Spatial data transfer standards.

Thematic mapping – Measurement in GIS: length, perimeter and areas – Query analysis – Reclassification – Buffering - Neighbourhood functions - Map overlay: vector and raster

overlay – Interpolation – Network analysis –Digital elevation modelling. Analytical Hierarchy Process, – Object oriented GIS – AM/FM/GIS – Web Based GIS.

Spatial data sources – 4M GIS approach water resources system – Thematic maps - Rainfall-runoff modelling – Groundwater modeling – Water quality modeling - Flood inundation mapping and Modelling – Drought monitoring – Cropping pattern change analysis –Performance evaluation of irrigation commands. Site selection for artificial recharge - Reservoir sedimentation

References

1	Lillesand, T.M. and Kiefer, R.W., "Remote Sensing and Image Interpretation" 3rd Edition. John Wiley and Sons, New York. 1993.
2	Burrough P.A. and McDonnell R.A., "Principles of Geographical Information Systems",.Oxford University Press. New York. 1998.
3	Ian Heywood Sarah, Cornelius and Steve Carver "An Introduction to Geographical Information Systems". Pearson Education. New Delhi, 2002.
4	"Centre for Water Resources", Change in Cropping Pattern in Drought Prone Chittar Sub-basin, Project Report, Anna University, Chennai, 2002.
5	"Centre for Water Resources", Post-Project Evaluation of Irrigation Commands

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Have Sound fundamental understanding of the GIS and remote sensing technologies
CO2	Understand the basic principles underlying the GIS based management of water resources and environment.
CO3	Familiar with the GIS-based analytical and problem-solving techniques for sustainable planning and management of water resources and environmental problems.
CO4	Understand types of remotely sensed images and data available for water resource applications.
CO5	Develop a project report and can develop Water Resource Information Systems (WRIS) for regional and basin scale.

CEPE46 ADVANCED GEOSPATIAL TECHNIQUES

Course Code	**:**	CEPE46
Course Title	**:**	**Advanced Geospatial Techniques**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC13
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn hyperspectral remote sensing basics such absorption feature causes, spectral measurement
CLO2	To familiarize LiDAR remote sensing concepts and applications
CLO3	To familiarize thermal radiation laws, terrain thermal properties, data gathering procedures
CLO4	To learn about active and passive microwave remote sensing and polarimetry techniques
CLO5	To provide exposure on satellite missions and applications using advances remote sensing.

Course Content

Hyperspectral remote sensing: causes of absorption feature in the spectra-hyperspectral image and spectral measurement techniques -atmospheric correction techniques- pre-processing of hyperspectral images -processing of measured lab/field spectra; endmember extraction; sub-pixel classification and information extraction

LiDAR System Design and Platforms- Principle and Properties of LASER- Doppler LiDAR - Platforms: Terrestrial, Airborne and Space borne LiDAR – Space Borne Radar Altimeter for mapping- LiDAR Mapping Principles - Synchronization of GPS- LiDAR technology for 3D urban modelling

Thermal Remote Sensing: introduction to thermal remote sensing, available spaceborne thermal sensors, Temperature-Emissivity Separation (TES) techniques, information extraction, advance quantitative analyses of thermal imagery and accuracy assessment

Passive and active microwave radiometry, radar equation, range and azimuth resolutions, concept of SAR, SAR image distortions, radar image interpretation, microwave scattering of land surface, SAR interferometry, Polarimetric SAR

Application of advanced remote sensing techniques in earth and planetary exploration, and civil engineering- TerraSAR X, ERS 1and2 ENVISAT, RADARSAT, ALOS, RISAT, Sentinel 1 and GRACE satellite- Polarimetric Applications: Soil tillage, crop productivity - snow mapping-sea-ice structure and type- forest type mapping – Soil moisture mapping- Soil salinity estimation- Flood/Wetland mapping – Marine winds – oil slick detection – ship detection. Interferometric Applications Vegetation height estimation – Tectonic deformations: pre, co-and post-seismic deformations – Ground Subsidence: Oil and Ground water extraction, Mine subsidence – Landslide detection - Reclaimed Land monitoring - Glacier monitoring: regular ice stream movement and tidal flexing of glaciers –volcanic inflation and deflation

References

1	Introduction to Microwave Remote Sensing by Iain H. Woodhouse, CRC, 2004.
2	Polarimetric Radar Imaging. From Basics to Applications by Lee, J.-S. andPottier, E., CRC Press, 2009.
3	Pinliang Dong, Qi Chen, LiDAR Remote Sensing and Applications**,** 1st Edition, CRC

	Press 2018
4	Michael Renslow, Manual of Airborne Topographic LiDAR, The American Society for Photogrammetry and Remote Sensing, 2013.
5	Hyperspectral Remote Sensing – Fundamentals & Practices by Ruiliang Pu, CRC Press 2017
6	Thermal Infrared Remote Sensing Sensors, Methods, Applications Springer Publication 2013

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Show expertise in hyperspectral remote sensing, including spectral measurement
CO2	Apply LASER properties, Doppler LiDAR, and GPS synchronization to 3D urban modeling and mapping across platforms
CO3	Use thermal remote sensing data to separate temperature-emissivity and applications
CO4	Analyze and interpret passive and active microwave radiometry data including SAR and polarimetric SAR.
CO5	Use various satellite images and advanced remote sensing techniques for environmental applications

CEPE47 THERMAL & HYPERSPECTRAL REMOTE SENSING

Course Code	**:**	CEPE47
Course Title	**:**	**Thermal & Hyperspectral Remote Sensing**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC13
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To Learn thermal infrared and hyperspectral remote sensing basics and history.
CLO2	To familiarize thermal radiation laws, terrain thermal properties, data gathering procedures, and environmental factors.
CLO3	To understand thermal and hyperspectral sensors and picture acquisition, preprocessing, and correction.
CLO4	To Learn to understand thermal and hyperspectral images, focusing on emissivity, image analysis components, and data preprocessing.
CLO5	To provide exposure on satellite missions and applications

Course Content

Introduction- History - Thermal Infrared radiation principles – Thermal Radiation Laws – Thermal Properties of Terrain – Data collection methods – Environmental Consideration - Thermal sensors and characteristics – thermal image characters–image degradation

sources & correction

Interpretation of thermal images, Emissivity conservation, Thermal inertia considerations, Factors effecting analysis of thermal images- Data Preprocessing- Image Normalisation - Radiometric calibration, atmospheric correction, and geometric correction.

Introduction to Hyperspectral Remote Sensing- Diffraction principles - field spectrum – BDRF and spectral reflectance & imaging spectrometry- sensors - virtual dimensionality- Viewing – Hughe‘s phenomenon - Data reduction, Calibration and normalization

Spectral library – response functions – MNF transformation – library matching, spectral angle mapper, BBMLC-spectral mixture analysis – end member extraction – spectral unmixing- MIA analysis concepts - PCF, PCA, WPCA spectral transformation – band detection, reduction and selection principles-data compression

Satellite Missions- Applications- Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)-MODIS-Landsat TIRS- Sentinel 2- Case studies – Land surface Temperature- Sea surface Temperature-Vegetation Monitoring-forest fire mapping- Mineral Mapping- Urban heat islands- Geological Mapping- Volcanic Monitoring.

References

1	Thomas M. Lillesand, Ralph W.Kiefer and Jonathan W.Chipman, Remote Sensing and Image interpretation, JohnWiley and Sons, Inc, New York,2015.
2	Richards, Remote sensing digital Image Analysis-An Introduction Springer -Verlag, 5th edition 2013.
3	John R. Jenson: Remote Sensing of the environment, Pearson, 2011, 2nd edition Gibson, P. J. Introductory Remote Sensing-Principles and Concepts, Taylor and Francis Press.
4	Hyperspectral Remote Sensing – Fundamentals & Practices by Ruiliang Pu, CRC Press 2017
5	Thermal Infrared Remote Sensing Sensors, Methods, Applications Springer Publication 2013

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Understand thermal radiation, and data gathering environmental conditions.
CO2	Use thermal and hyperspectral sensors to acquire and preprocess remote sensing images.
CO3	Getting idea about Hyper spectral remote sensing basics
CO4	Interpret and compress data using hyperspectral remote sensing technologies
CO5	Apply the geospatial and image processing techniques for various environmental problems.

STREAM V: TRANSPORTATION ENGINEERING

CEPE50 TRAFFIC ENGINEERING AND SAFETY

Course Code	**:**	CEPE50
Course Title	**:**	**Traffic Engineering and Safety**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC19
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the fundamentals of traffic stream characteristics
CLO2	To learn the skills of traffic control and management
CLO3	To learn the methods of safe intersection design
CLO4	To learn the importance and methods of accident investigation and prevention
CLO5	To understand the concepts of road safety audit and safety improvement methods

Course Content

Traffic stream characteristics:, Fundamental parameters and relationship of traffic flow, speed and concentration. Traffic stream models. Speed data collection and analysis, Density and travel time measurement and analysis, Moving Observer Method, Automated Traffic Measurements - Traffic forecasting and growth studies. Capacity and level of service of roads. Pedestrian studies – flow characteristics - Design principles of pedestrian facilities.

Traffic Management: Parking studies – parking parameters, parking surveys, parking requirements - on street and off street parking. Lay-byes and bus stops. Principles of Traffic Control: Basics of traffic management. Traffic System Management - speed control, one way streets, reversible lanes, access control, bus priority measures, turning restrictions.

Design of Intersections for Safety: Uncontrolled intersections, Conflicts at intersections, Channelization, Traffic islands, Design of median islands, turning vehicle templates Design of traffic rotaries. Traffic signal design - Design Principles of Traffic Signal, Signal Coordination, Vehicle Actuated Signals and Area Traffic Control. Design of Grade Separated interchanges - trumpet, diamond, cloverleaf, rotary and directional.

Accident Investigation and Prevention: Characteristics of road accidents, causes of accidents: road – driver – vehicle - environment, Significance of accident data, Accident recording and analysis - Crash reporting and collision diagrams - Statistical Interpretation and Analysis of Crash Data. Identification of potential sites for treatment - Safety countermeasures. Monitoring and evaluation.

Road Safety Audit – Overview, stages of road safety audit, audit process, checklists and elements of good road safety audit. Highway safety improvement program - Safety Education, Traffic Law Enforcement. Road Safety Management System. Case studies.

References

1.	*Khanna, S. K., Justo, C. E. G. and Veeraragavan A., Highway Engineering, Nem Chand and Bros, Roorkee, 2014.*
2.	*Kadiyali, L.R, Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, 2011.*
3.	*IRC SP: 88 – 2010*
4.	*Rune Elvik, Alena hoye, Truls Vaa and Michael Sorensen, The handbook of Road Safety Measures, Emerald Group Publishing Limited, 2009*
5.	*Highway Safety Manual, ITE, 2010*

Course Outcomes (CO)

At the end of the course student will be able

CO1	Carry out traffic surveys
CO2	Implement traffic system management
CO3	Carry out intersection design for safety
CO4	Record and analyse accident data and suggest countermeasures
CO5	Carry out road safety audit

CEPE51 PAVEMENT ANALYSIS AND DESIGN

Course Code	**:**	CEPE51
Course Title	**:**	**Pavement Analysis and Design**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC19
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To study about the types and components of pavements
CLO2	To learn about the stresses in flexible pavements and equivalent single wheel load
CLO3	To study the design of flexible pavements
CLO4	To learn about the stresses in rigid pavements
CLO5	To study the design of rigid pavements

Course Content

Pavements - Types and Components - Factors affecting Design and Performance of Pavements, Comparison between Highway and Airport pavements - Functions and Significance of Sub grade properties.

Stresses in Flexible Pavements - Stresses and Deflections in Homogeneous Masses - Burmister's 2-layer, 3-layer Theories - Wheel Load Stresses, ESWL of Multiple Wheels, Repeated Loads and EWL factors.

Flexible Pavement Design - Empirical - Semi-empirical and Theoretical Approaches; Principles and procedure, Design, Advantages and applications of different Pavement Design Methods – IRC Method of Design.

Stresses in Rigid Pavements - Types of Stresses and Causes - Factors influencing the Stresses, General conditions in Rigid Pavement Analysis, ESWL, Wheel Load Stresses, Warping Stresses, Friction Stresses, Combined Stresses.

Rigid Pavement Design - Types of Joints in Cement Concrete Pavements and their Functions, Joint Spacing, Design of Slab Thickness, Design of Joint Details for Longitudinal Joints, Contraction Joints and Expansion Joints, IRC Method of Design.

References

1.	Yoder and Witezak, Principles of Pavement Design¸ John Wiley and sons, 1975 2. Yang H. Huang, Pavement Analysis and Design, Pearson Prentice hall, 2004.
2.	IRC: 37 - 2012, Guidelines for the Design of Flexible Pavements
3.	IRC: 58 - 2011, Guidelines for the Design of Plain Jointed Rigid Pavements for Highways
4.	Yoder and Witezak, Principles of Pavement Design¸ John Wiley and sons, 1975 2. Yang H. Huang, Pavement Analysis and Design, Pearson Prentice hall, 2004.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Identify the pavement components and compare highway and airport pavements.
CO2	Calculate the stresses and ESWL in flexible pavements.
CO3	Design the flexible pavement using empirical, semi empirical and IRC methods.
CO4	Analyze the warping, friction, wheel load stress and calculate the combined stress.
CO5	Design rigid pavements by IRC method and evaluate the pavements.

CEPE52 TRANSPORTATION PLANNING

Course Code	**:**	CEPE52
Course Title	**:**	**Transportation Planning**
Type of Course	**:**	PE
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To know about the processes and concepts of transportation planning
CLO2	To study about trip generation
CLO3	To study about trip distribution
CLO4	To study about modal split analysis
CLO5	To study about trip assignment

Course Content

Transportation Planning Process and Concepts - Role of transportation -

Transportation problems - Urban travel characteristics - Concept of travel demand - Demand function - demand estimation - Sequential, recursive and simultaneous processes

Trip Generation Analysis - Zoning - Types and sources of data – O-D studies -

Expansion factors - Accuracy checks - Trip generation models - Zonal models - Household models - Category analysis - Trip attractions of work centers.

Trip Distribution Analysis - Trip distribution models - Growth factor models - Gravity models - Opportunity models.

Mode Split Analysis - Mode split Models - Mode choice behaviour, competing modes, Mode split curves, Probabilistic models.

Traffic Assignment - Route split analysis: Elements of transportation networks, Nodes and links - minimum path trees - all-or-nothing assignment - Multipath assignment - Capacity restraint.

References

1.	Hutchinson B.G., Principles of Urban Transportation System Planning, McGraw Hill, 2007.
2.	Bruton M. J., Introduction to Transportation Planning, Hutchinson, London, 1992.
3.	C. Jotin Khisty, B. Kent Lall, Transportation Engineering, Prentice Hall of India, 2002.
4.	C.S. Papacostas and P.D. Prevedouros, Transportation Engineering and Planning, Prentice Hall of India Pvt. Ltd., 2001.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Apply the principles of the transportation planning process and demand estimation.
CO2	Analyse the trip production and trip attraction models.
CO3	Analyse the growth factor, gravity and opportunity models.
CO4	Apply the mode choice behaviour and mode split models.
CO5	Apply the shortest path models for route assignment

CEPE53 URBAN TRANSPORTATION SYSTEMS

Course Code	**:**	CEPE53
Course Title	**:**	**Urban Transportation Systems**
Type of Course	**:**	PE
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the characteristics of various urban modes and service types
CLO2	To discuss transportation demand and network planning
CLO3	To learn the concepts of transit scheduling
CLO4	To study the planning aspects of terminals
CLO5	To be acquainted with integrated public transport planning

Course Content

Urban modes and service types - Technological and operational Characteristics – environmental considerations – relative cost economics – criteria for selection

Transportation Demand estimation- Data requirements, Network planning - Corridor identification - Route Systems and Capacity, Comprehensive mobility plan.

Scheduling procedure and patterns –Fleet Requirement – Bus scheduling – Frequency and Headway-Way capacity and station capacity.

Planning and design of terminals - Bus stop capacity – Depot location - Depot layout, Parking patterns.

Integrated public transport planning – Transit oriented development, Preferential treatment for high occupancy modes, promoting non-motorized modes of transport - case studies.

References

1	Black, Alan, *Urban Mass Transportation Planning*, McGraw- Hill,Inc., New York,1995.
2	Vukan, R. Vuchic, *Urban Transit Systems and Technology*, John –Wiley & Sons, New Jersey, 2007.
3	Sigurd Grava, *Urban Transportation Systems – Choices for Communities*, The McGraw-Hill Companies, 2004.
4	Ceder, Avishai. *Public Transit Planning and Operation: Theory, modelling and pra*ctice, Butterworth-Heinemann publications, 2007.
5	Mehrdad, Ehsani, Fei-Yue, Wang and Gary, L. Brosch., *Transportation technologies for sustainability*, Springer, 2013.
6	Black, Alan, *Urban Mass Transportation Planning*, McGraw- Hill,Inc., New York,1995.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	compare the various urban modes and service types
CO2	quantify transportation demand and identify planning corridor
CO3	apply the concepts of transit scheduling
CO4	evaluate the planning aspects of terminals and depots
CO5	describe the concepts of integrated public transport planning

CEPE54 INTELLIGENT TRANSPORTATION SYSTEMS

Course Code	**:**	CEPE54
Course Title	**:**	**Intelligent Transportation Systems**
Type of Course	**:**	PE
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn the fundamentals of ITS
CLO2	To understand the different types of sensors
CLO3	To study the ITS functional areas
CLO4	To have an overview of ITS implementation in developed countries
CLO5	To learn the implantation, and advantages of ITS in field, with case studies from developed countries

Course Content

Introduction to Intelligent Transportation Systems (ITS) – Definition of ITS and Identification of ITS 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.

Telecommunications in ITS – Importance of telecommunications in the ITS system, Information Management, Traffic Management Centres (TMC). Vehicle – Roadside communication – Vehicle Positioning System.

ITS functional areas – Advanced Traffic Management Systems (ATMS), Advanced Traveler 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 and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.

Automated Traffic Infrastructures – V2X Communications– Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries, Case studies.

References

1	ITS Handbook 2000: *Recommendations for World Road Association (PIARC)* by Kan Paul Chen, John Miles.
2	Sussman, J. M., *Perspective on ITS*, Artech House Publishers, 2005.
3	National ITS Architecture Documentation, US Department of Transportation, 2007 (CD-ROM).

4	Chowdhary, M.A. and A Sadek, *Fundamentals of Intelligent Transportation systems planning*. Artech House Inc., US, 2003.
5	Williams, B., Intelligent transportation systems standards. Artech House, London,2008.
6	Ni, Daiheng. Traffic Flow Theory. Butterworth-Heinemann, Elsevier, 2016
7	P. K. Sarkar, A.K. Jain. Intelligent Transport Systems. PHI Learning, 2018.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	understand the sensor technologies
CO2	understand the communication techniques
CO3	apply the various ITS methodologies
CO4	understand the user needs
CO5	define the significance of ITS from developed countries perspective and implications for Indian conditions

CEPE55 PAVEMENT MANAGEMENT SYSTEM

Course Code	**:**	CEPE55
Course Title	**:**	**Pavement Management System**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC19
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the pavement performance evaluation
CLO2	To know about the pavement structure evaluation and field tests
CLO3	To understand the basic concepts of Pavement Management System.
CLO4	To develop the performance prediction models
CLO5	To learn pavement life cycle cost analysis and optimization of pavement maintenance and rehabilitation

Course Content

Pavement distresses Evaluation – General concepts – functional evaluation, condition surveys, serviceability-performance concept, characterization of pavement roughness, equipment for evaluating roughness and skid resistance

Pavement Structure Evaluation and Field Tests - Factors affecting Structural Condition of Flexible and Rigid Pavements- Pavement Deterioration- Evaluation by Non-Destructive Tests such as Benkelman Beam Rebound Deflection, FWD, Plate Load Test - Evaluation by Destructive Test Methods, and Specimen Testing.

Introduction to Pavement Management: Pavement Management Levels and Functions-network and project levels of pavement management, influence levels of PMS components,

key consideration in the application of a total pavement management system concept, function of pavement evaluation.

Pavement performance prediction - concepts, techniques for developing prediction models– structural conditional deterioration models, functional condition deterioration models.

Pavement Maintenance Management - expert system for pavement evaluation and rehabilitation, Pavement Life Cycle Cost Analysis, Priority Programming, Budget Level Evaluation, optimization of pavement maintenance and rehabilitation.

References

1	R Srinivasa Kumar, *Pavement Evaluation and Maintenance Management System*, Universities Press (India) Pvt. Ltd, 2014.
2	Rajib B. Mallick,Tahar El-Korchi, *Pavement Engineering: Principles and Practice*, Second Edition, CRC Press
3	Haas, R., Hudson, W. and Zaniewski, J., Modern Pavement Management, Krieger Publishing Company. McGraw- Hill, 1994
4	Derek Pearson, *Deterioration and Maintenance of Pavements*, ICE Publishing, 2011
5	Relevant IRC codes, CRRI and HDM 4 Manuals

Course Outcomes (CO)

At the end of the course student will be able to

CO1	comprehend principles for evaluating pavement performance and assessing pavement distresses.
CO2	gain knowledge of pavement structure evaluation techniques and field tests
CO3	learn to develop and utilize performance prediction models for pavement management
CO4	utilize performance prediction models for pavement management
CO5	conduct life cycle cost analysis and optimize maintenance and rehabilitation strategies

CEPE56 PAVEMENT MATERIAL CHARACTERISATION

Course Code	**:**	CEPE56
Course Title	**:**	**Pavement Material Characterisation**
Type of Course	**:**	PE
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To study the properties and test on aggregate for road construction
CLO2	To understand the properties of conventional and modified binders

CLO3	To introduce to the principles of bituminous pavement construction
CLO4	To learn the procedure of PQC mix design
CLO5	To study the use of composites and recycled waste products in road construction

Course Content

Aggregate: Nature and properties – aggregate requirements – types and processing – aggregates for pavement base – aggregate for bituminous mixture – tests on aggregate – specification.

Bituminous Materials: conventional binders – production – types and grade – physical and chemical properties and uses, specification of binders – Modified Bitumens - Type of Bitumen Modifiers- tests on bituminous materials.

Bituminous Mixes: Mechanical properties - Resilient modulus, dynamic modulus and fatigue characteristics of bituminous mixes. Marshall method of mix design, Performance based Bitumen and SUPERPAVE mix design method

Cement /concrete-based materials: Cement – properties – PQC – properties, mix design, behaviour, performance, Special types of cement concrete, Tests on Cement and Concrete mixes.

Reclaimed / Recycled Waste Products and other materials: Reclaimed Materials – waste products in road construction –– self-healing and smart materials – locally available materials. Composites, Plastics and Geosynthetics.

References

1	Kandhal, Veeraragavan, Rajan, *Bituminous Road Construction in India* PHI Learning PVT, India, Second Edition, 2023.
2	M.Rashed Isla, Rafiqul A. Tarefder, *Pavement Design, Materials, Analysis, and Highways*, McGraw-Hill Education, 7 Jul 2020
3	Barth Edwin J., *Asphalt: Science and Technology*, Gordon and Breach Science Publishers, 2018.
4	Shan Somayaji, *Civil Engineering Materials*, second edition, Prentice Hall Inc., 2016.
5	P. T. Sherwood, *Alternative Materials in Road Construction*, Thomas Telford Publication, London, 1997.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	understand the properties and test procedures of aggregate
CO2	understand the properties of bituminous materials
CO3	perform bituminous mix design using various methods
CO4	do PQC mix design and can conduct various tests on cement and concrete
CO5	use recycled and other materials in road construction

CEPE57 SUSTAINABLE TRANSPORTATION

Course Code	**:**	CEPE57
Course Title	**:**	**Sustainable Transportation**
Type of Course	**:**	PE
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the concept of sustainable transportation planning
CLO2	To learn the various evaluation techniques of non-motorized transportation
CLO3	To be introduced to the fundamentals of planning for pedestrians
CLO4	To be introduced to the fundamentals of planning for bicyclists
CLO5	To understand the sustainable policies and technologies

Course Content

Planning for Sustainability- Urban form, Indicator based planning, landuse transportation integration, Compact City, Public Transit, TOD, NMT, First and Last Mile Connectivity.

Evaluation of non-motorized transportation-Surveys, Demand Estimation and Analysis; Evaluation Techniques; Pedestrian Condition Evaluation Techniques; Prioritizing Improvements and Selecting Preferred Options

Pedestrian facilities and planning - Types of pedestrians and Characteristics; Pedestrian standards and improvements; Pedestrian facility Design, LOS; Pedestrian safety programs.

Planning for bicyclists: Types of cyclists and Bikeways; Integrating cycling into roadway planning; Bicycle network planning; Design aspects of Bicycle paths; Bicycle Parking/storage Facilities.

Sustainable policies and technology: Speed and speed limit policies, national policies, sustainable travel demand management; public awareness; Alternative Cleaner Fuels, vehicle technologies, nationally appropriate mitigation actions.

References

1	Black, W. R., *Sustainable Transport: Definitions and Responses*, In Transportation Research Board, Integrating Sustainability into the Transportation Planning Process, Conference Proceedings 37. Washington, D.C., National Research Council, 2005.
2	Black, W.R., *Sustainable transport: Problems and Solutions*. Gulford Press, New York, 2010.
3	Cervero, R. *Accessible Cities and Regions: A Framework for Sustainable Transport and Urbanism in the 21st Century*. Center for Future Urban Transport, Institute of Transportation Studies, University of California, Berkeley, 2005.
4	Tolley, R., *Sustainable Transport: Planning for Walking and Cycling in Urban Environments*, CRC Press, 2003.

5	Preston, L. Schiller, Eric, C. Brunn and Jeffrey, R. Kenworthy. *An Introduction to Sustainable Transportation: Policy, Planning and Implementation*, Earthscan, 2010.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	specify transport planning strategies for sustainable development
CO2	evaluate strategies for development of non-motorised transport
CO3	specify actions for planning for pedestrian facilities
CO4	specify actions for planning for bicyclists' facilities
CO5	elaborate on sustainable policies and technologies

STREAM VI: STRUCTURAL ENGINEERING

CEPE60 ELEMENTARY STRUCTURAL DYNAMICS

Course Code	**:**	CEPE60
Course Title	**:**	**Elementary Structural Dynamics**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC10
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	Understand the basic concepts of dynamic analysis and elements of vibratory systems
CLO2	To study the dynamic response of SDOF system
CLO3	To study the dynamic response of MDOF system
CLO4	Implement numerical methods for evaluating the dynamic response of structures
CLO5	Apply approximate solution methods for dynamic analysis

Course Content

Introduction to Dynamic analysis - Elements of vibratory systems. Simple Harmonic Motion - – D'Alembert's principle – Degrees of freedom – Lumped mass procedure - Single degree of freedom system

Free vibration of single degree of freedom system- undamped free vibration - Damped free vibration - Evaluation of damping – Response to harmonic loading − response to impulsive loading loading (blast or earthquake) - Duhamel's integral – Transmissibility

Multi degree of freedom system (MDOF) – Equation of motion for mdof systems - Eigen value problem - Natural frequencies and mode shapes − orthogonality conditions – Response to free and forced excitations - Modal Analysis - Vibration isolation

Numerical evaluation of dynamic response – Time stepping method – methods based of interpolation of excitation. Idealization of multi-storeyed frames - Deterministic analysis of

earthquake response – response spectrum - Numerical analysis in the frequency domain, fast Fourier transform analysis.

Approximate solutions - Rayleigh's method, Rayleigh-Ritz method, Dunkerley's method, Holzer's and Stodola's methods

References

1.	Mario Paz, Structural Dynamics, CBS, Publishers, 1987.
2.	Roy R Craig, Jr., Structural Dynamics, John Wiley & Sons, 1981.
3.	A.K. Chpora "Dynamics of Structures Theory and Application to Earthquake Engineering" Pearson Education, 2001
4.	Madhujit Mukhopadhyay "Structural Dynamics Vibrations and Systems" Springer, 2021
5.	Keith D. Hjelmstad "Fundamentals of Structural Dynamics Theory and Computation" Springer, 2023

Course Outcomes (CO)

At the end of the course student will be able

CO1	Demonstrate an understanding of the basic concepts of dynamic analysis and the elements of vibratory systems
CO2	Develop and use mathematical models for single degree of freedom (SDOF) systems using the lumped mass procedure
CO3	Formulate and solve equations of motion for MDOF systems, identifying natural frequencies, mode shapes, and orthogonality conditions
CO4	Conduct deterministic analyses of earthquake responses for multi-storeyed frames using response spectra
CO5	Apply approximate methods for dynamic analysis, including Rayleigh's method, Rayleigh-Ritz method

CEPE61 MAINTENANCE AND REHABILITATION OF STRUCTURES

Course Code	**:**	CEPE61
Course Title	**:**	**Maintenance and Rehabilitation of Structures**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC14
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To provide a comprehensive knowledge on the diagnosis of damage, condition assessment of structures and quality of material application relating to maintenance and rehabilitation of structures.
CLO2	To identify performance factors and design errors affecting structural integrity.
CLO3	To apply preventive measures and condition rating procedures for structural

	maintenance.
CLO4	To recognize corrosion mechanisms and select protective methods for structural durability.
CLO 5	To implement effective repair and strengthening techniques for distressed structures.

Course Content

Performance of construction materials and components in services for strength, permeability, thermal properties and cracking effects due to climate, temperature, chemicals, wear and erosion, Design and construction errors, Effects of cover thickness

Maintenance and Diagnosis Maintenance, Repair and rehabilitation, Facets of Maintenance, Importance of Maintenance, Preventive measures based on various aspects of inspection- Condition assessment and rating procedure for evaluating a damaged structure. Diagnosis of construction failures. Different types of concrete deterioration

Corrosion damages and protection Corrosion damage of reinforced concrete, methods of corrosion protection, Corrosion inhibitors, corrosion resistant steels, coatings, cathodic protection, rust eliminators. Causes of deterioration of concrete, steel, masonry and timber structures, surface deterioration, efflorescence, causes, prevention and protection. Materials and Techniques

Surface repair strategies and materials - Special concrete and mortar, concrete chemicals, expansive cement, polymer concrete sulphur infiltrated concrete, Ferro cement, fiber reinforced concrete, Surface preparation and protective treatments, - surface coatings, Waterproofing materialsMethods of repair in concrete, steel and masonry structures. Gunite and shotcrete, epoxy injection.

Strengthening and demolition-Strengthening of existing structures - repairs to overcome low member strength, deflection, cracking, chemical disruption, weathering, wear, fire, leakage, marine exposure, coatings for set concrete and steel reinforcement. Demolition techniques of structures - case studies.

References

1.	Raiker .R.N, ”Learning from Failures, Deficiencies in Design, Construction and Service”, - R&D Centre (SDCPL), Raikar Bhavan, Bombay 1987.
2.	Emmons P.H., Concrete Repair and Maintenance Illustrated, RS Means InC., 1993.
3.	Varghese P.C., Maintenance Repair and Rehabilitation & Minor Works of Buildings, PHI Learning Pvt. Ltd., 2014
4.	“Repair & Rehabilitation”, Compilation from The Indian Concrete Journal,– ACC – RCD Publication 2001.
5.	Allen .R.T, and Edwards .S.C, Shaw D.N, ”Repair of Concrete Structures”,Chapman and Hall, 2005
6	Newman A., Structural Renovation of Buildings, McGraw-Hill Education, 2000
7	Woodson R. D., Concrete Structures – Protection, Repair and Rehabilitation, Butterworth-Heinemann, Elsevier, 2009

Course Outcomes (CO)

At the end of the course student will be able

CO1	Diagnose the damage in distressed structures
CO2	Conduct condition assessment of structures
CO3	Select the proper repair materials and its application
CO4	Select methods to strengthen distressed structures
CO5	able to use proper demolition techniques w.r.t the requirements

CEPE62 CONCEPTUAL DESIGN OF STRUCTURES

Course Code	**:**	CEPE62
Course Title	**:**	**Conceptual Design of Structures**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC10
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To teach the importance of conceptual design of structures in the development of civilization
CLO2	To make students interpret structural behaviour from nature and the evolution of structural forms
CLO3	To motivate students to make various physical models of structures and learn the development of structural forms
CLO4	To teach the role of materials in shaping the structural forms, systems and analysis
CLO5	To provide a hands-on experience to students on the conceptual design of structures

Course Content

Introduction – Need for conceptual design of structures – logic of forms – material and technology – chronological development of structures

Understanding and interpretation of structural behaviour – Lessons from nature, primitive structures, master builders – Design through new possibilities

Lessons from physical models – Experiments on buildings, towers and bridge models - Case studies on structures based on conceptual design

Role of materials in shaping the structural forms, systems and analysis - Light and slender systems – Role of analysis, construction technology in the evolution of structures

Conceptual design of structures (hands-on) – a footbridge – a railway bridge – a tensegrity tower – a stadium – a building.

References

1.	Lecture notes of Professor Mike Schlaich on Conceptual and Structural Design, Technical University of Berlin
2.	Jean-Paul Lebet, Manfred A. Hirt, Conceptual and Structural Design of Steel and Steel-concrete composite bridges, EPFL Press, 2013
3.	Olga Popovic Larsen and Andy Tyas, Conceptual Structural Design bridging the gap between architects and engineers, Thomas Telford Publishing, 2003
4.	GIAN course content by Professor Mike Schlaich on Conceptual and Structural Design, Technical University of Berlin

Course Outcomes (CO)

At the end of the course student will be able

CO1	To understand the importance of conceptual design of structures
CO2	To interpret the structural behaviour from nature and the evolution of structural forms
CO3	To create physical models of structures and learn the development of structural forms
CO4	To learn the role of materials in shaping the structural forms, systems and analysis
CO5	To get a hands-on experience on the conceptual design of structures

CEPE63 PRESTRESSED CONCRETE STRUCTURES

Course Code	**:**	CEPE63
Course Title	**:**	**Prestressed Concrete Structures**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC18
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn the principles, materials, methods and systems of prestressing
CLO2	To know the different types of losses and deflection of prestressed members
CLO3	To learn the design of prestressed concrete beams for flexural, shear and tension and to calculate ultimate flexural strength of beam
CLO4	To learn the design of anchorage zones, composite beams, analysis and design of continuous beam
CLO5	To learn the design of water tanks

Course Content

Principles of prestressing - Materials of prestressing - Systems of prestressing - Losses in prestress – Analysis of members - Deflection of Prestressed Concrete members.

Slabs - Pre-tensioned and Post-tensioned beams - Design for flexure, bond , shear, and Torsion - IS code provisions - Ultimate flexural and shear strength of prestressed concrete

sections –Transmission of prestress - Design of end anchorage zones using IS code method.

Composite beams - Analysis and design. Partial prestressing - non-prestressed reinforcements.

Analysis of Cantilever and Continuous beams - Cable layout - Linear transformation - Concordant cables.

Design of compression members and tension members. Special topics Circular prestressing - Water tanks - Pipes - Analysis and design - IS Codal provisions.

References

1.	Lin. T.Y., Burns, N.H., Design of Prestressed Concrete Structures, John Wiley & Sons, 1982.
2.	RajaGopalan N. Prestressed Concrete, Narosa Publishing House, New Delhi, 2002.
3.	Raju K. N., Prestressed Concrete, McGraw Hill Education, 6th edition, 2018
4.	Nawy, E. G., Prestressed concrete a fundamental approach 4th edition, Pearson Education, Inc. New Jersery, US., 2003
5.	IS 1343: 2012. Prestressed concrete - code of practice, Bureau of Indian Standards (BIS), New Delhi, India., 2012

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Design a prestressed concrete beam accounting for losses
CO2	Design the anchorage zone for post tensioned members
CO3	Design prestressed composite members
CO4	Design prestressed continuous beams
CO5	Design prestressed water tanks

CEPE64 ADVANCED REINFORCED CONCRETE DESIGN

Course Code	**:**	CEPE64
Course Title	**:**	**Advanced Reinforced Concrete Design**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC18
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the design concept of various structures and detailing of reinforcements
CLO2	To understand the design of underground and elevated liquid retaining structures
CLO3	To study the design of material storage structures

CLO4	To know the effect of temperature on concrete structures
CLO5	To study the design of bridges subjected to IRC loading

Course Content

Earth Retaining structures - Retaining walls- types - cantilever and counterfort - design - drainage and other construction details.

Liquid Retaining structure - Water tanks - types - square, rectangular, circular - Design of underground and elevated tanks - design of staging - spherical & conical roof for circular tanks.

Material storage structures - Determination of lateral pressure on side walls of bunker - Rankine's theory - design of bunker - design of circular silo using Jansen's theory.

Environmental Structures - Chimneys - Principles and Design - Design of long columns.

Transportation structures - Bridges - Slab bridge - Design of single span slab bridge - Tee beam bridge - Design of Tee beam bridge with stiffness - Tee beam bridge with cross girders - Introduction to earthquake design.

Note: Assignments include the design and drawings of various RCC structures

References

1.	Vazirani, V.N., and Ratwani, Concrete Structures, Vol. IV, Khanna Publishers, New Delhi, 1995.
2.	Dayaratnam, P., Design of Reinforced Concrete Structures, Oxford & IBH Publishers & Co., New Delhi, 2005.
3.	Victor, D.J., Essentials of Bridge Engineering, Oxford & IBH Publishers Co., New Delhi, 1991.
4.	Raju N. K., Advanced Reinforced Concrete Design, CBS Publishers and Distributors Pvt. Ltd., India, 2016
5.	Varghese P.C., Advanced Reinforced Concrete Design, PHI, India, 2nd Edition, 2010.
6.	IS456-2000 Code of practice for Plain and reinforced concrete code of practice.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Apply the concepts of liquid retaining structures
CO2	Design material storage structures using various theories
CO3	Apply the concepts of environmental and transportation structures
CO4	Demonstrate the detailing of reinforcement
CO5	Draw the various RCC structures

CEPE65 ADVANCED STEEL STRUCTURAL ELEMENTS

Course Code	**:**	CEPE65
Course Title	**:**	**Advanced Steel Structural Elements**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC24
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To study the behavior and design of member subjected to combined forces
CLO2	To study the design of Gantry girder, welded plate girder, stiffeners and connections.
CLO3	To calculate the wind forces on various types of structures.
CLO4	To understand the design of industrial buildings/bents
CLO5	To understand the design of moment resisting connections used in steel frames

Course Content

Introduction to beam-column - behavior - strength interaction - design of beam column - beam - column subjected to combined forces - column bases - slab base - gusseted base - moment resistant base plate.

Welded plate girders – analysis and design using IS800-2007 - curtailment of flange plates –stiffeners – Introduction to hybrid girders - analysis and design of gantry girder.

Design of industrial building - roofing, cladding and wall material - structural components and framing - types of roof trusses - components - wind load estimation for different type of structures for various zones.

Approximate analysis of industrial bents/PEB - design of purlins and wall girts using Channel and Angle sections; cold formed steel purlin – Design of wind bracings – wind girders – gable columns

Analysis and design of framed connections.

Note: Assignments include the design and drawings of various steel structures

References

1.	Subramanian N, Design of Steel Structures, Oxford University Press, New Delhi 2008.
2.	Bhavikatti, S.S., Design of Steel Structures, I.K. International Publishing House Pvt. Ltd., New Delhi, 2010.
3.	IS 800 - 2007, Code of practice for general construction in steel, Bureau of Indian Standards, New Delhi.
4.	IS875 Part (3) - 1987, Code of Practice for Design Loads (other than earthquake) for buildings and structures: Wind loads. Bureau of Indian Standards, New Delhi.
5.	SP6 (1) - 1964, IS hand book for structural Engineers. Bureau of Indian Standards,

	New Delhi.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Design eccentrically loaded compression members (Beam-Columns) and their base plates.
CO2	Design welded plate girder and Gantry girder for industrial structures
CO3	Calculate the wind load acting on various structures to be built in various locations.
CO4	Design Industrial structures and their components such as girts, wind girders, bracings systems purlins etc.
CO5	Design the moment resisting connections used in steel frames

CEPE66 ADVANCED STRUCTURAL ANALYSIS

Course Code	**:**	CEPE66
Course Title	**:**	**Advanced Structural Analysis**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC15
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the influence line concepts for indeterminate structures
CLO2	To understand the methods of analysis of intermediate trusses for external loads, lack of fit and thermal effect
CLO3	To study behaviour of arches and their methods of analysis
CLO4	To know the concept and analysis of cable stayed bridge
CLO5	To study the multi storey frames subjected to gravity loads and lateral loads

Course Content

Influence lines - Maxwell Betti's theorem - Muller Breslau's principle and its application. Influence lines for continuous beams and single bay, single storey portals with prismatic members.

Analysis of plane truss with one or two redundants - trusses with lack of fit - Thermal stresses - Settlement of supports - Trussed beams.

Theory of arches - Analysis of three hinged, two hinged and fixed arches - influence lines, rib shortening, settlement and temperature effects.

Analysis of cables - Suspension bridges with three and two hinged stiffening girders - influence lines.

Analysis of multistorey frames for gravity and lateral loads by approximate methods - Substitute frame - Portal and Cantilever methods – Introduction to earthquake load

References

1.	Punmia, B.C, Theory of Structures, Laxmi Publications, 2000.
2.	Timoshenko, S.P.,Young, D.H., Theory of Structures, Tata McGraw Hill, 1983.
3.	Wang. C.K., Intermediate Structural Analysis, International Text Book Co, 1983.
4.	Hibbeler. R.C., Structural Analysis, Pearson Education (Singapore) Ptc. Ltd., Indian Branch, 2002.
5.	Moskvin V, Concrete and Reinforced Structures - Deterioration and Protection, Mir Publishers, Moscow, 1980.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Demonstrate the concepts of qualitative influence line diagram for continuous beams and frames.
CO2	Apply the methods of indeterminate truss analysis.
CO3	Demonstrate the behavior of arches and their methods of analysis.
CO4	Analyse cable suspension bridges.
CO5	Analyse multistory frames subjected to gravity loads and lateral loads.

CEPE67 DESIGN OF OFFSHORE AND COASTAL STRUCTURES

Course Code	**:**	CEPE67
Course Title	**:**	**Design of Offshore and Coastal Structures**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC18, CEPC24
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand different types of offshore structures
CLO2	To study the different types of operational loads and environmental loads
CLO3	To understand the different types of waves and wave deformation
CLO4	To learn about breakwaters, stability of coastal structures and sediment transport
CLO5	To study the different coastal features and coast protection methods

Course Content

Types of offshore structures and conceptual development - Analytical models for jacket structures - Materials and their behaviour under static and dynamic loads - Statutory regulations - Allowable stresses - Various design methods and Code Provisions - Design specification of API, DNV, Lloyd's and other classification societies - Construction of jacket and gravity platforms

Operational loads - Environmental loads due to wind, wave, current and buoyancy -

Morison's Equation - Maximum wave force on offshore structure - Concept of Return waves - Principles of Static and dynamic analyses of fixed platforms - Use of approximate methods - Design of structural elements.

Waves in shallow waters - shoaling, refraction, diffraction and breaking- Interaction currents and waves Sediment characteristics - Initiation of sediment motion under waves - Wave run-up and overtopping Radiation stress-wave set-up and wave set- down Mechanics of Coastal Sediment transport - Limits for littoral drift

Breakwaters- Classification, Design and application in coastal protection and harbor planning Distribution of long shore currents and Sediment transport rates in Surf zone - Stability of tidal inlets Wave forces on coastal structures

Coastal Features - Beach Features - Beach cycles - Beach Stability - Beach profiles Coastal erosion, Planning and methods of coast protection works - Design of shore defense structures Case studies on coastal erosion and protection

References

1.	Hydrodynamics of Offshore Structures by S.K. Chakrabarti, Springer-Verlag 2. Handbook of Offshore Engineering by S.K. Chakrabarti, Elseviers, 2005.
2.	Offshore pipelines by B. Gou, S. Song, J. Chacko and A. Ghalambor, GPP Publishers,2006
3.	Structural Stability - Theory and Implementation by W.F.Chen and E.M.Lui by Elsevier
4.	Reeve,D., Chadwick, A. and Fleming, C. Coastal Engineering-Processes, theory and design practice, Spon Press, Taylor & Francis Group, London & Paris,2004.
5.	Silvester,R. and Hsu,J.R.C. Coastal Stabilisation, Advances on Ocean Engineering-Volume 14, World Scientific, 1997.
6.	Kamphius,J.W. Introduction to coastal Engineering and Management, Advances on Ocean Engineering-Volume 16, World Scientific,2002

Course Outcomes (CO)

At the end of the course student will be able

CO1	Gain knowledge on different types of offshore structures
CO2	Understand the different types of loads acting on offshore structures
CO3	Gain understanding on waves in shallow water, diffraction, reflection and diffraction
CO4	Design breakwaters and other coastal defense structures
CO5	Understand the concepts of littoral drift, wave forces and coastal erosion protection

CEPE68 PREFABRICATED STRUCTURES

Course Code	**:**	CEPE68
Course Title	**:**	**Prefabricated Structures**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC18, CEPC24

Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the concepts and behaviour of prefabrication and types and its systems.
CLO2	To perform analysis and design of cross section and the joints in structures
CLO3	To analyze and design of prefabricated concrete members
CLO4	Obtain knowledge in design of cross section and the joints.

Course Content

Need for prefabrication – Types of prefabrication- Principles - Materials - Modular co-ordination – Standardization – Systems Production – Transportation

Prefabrication of load carrying members – Disuniting of structures – Design of cross section of load carrying members- handling and erection stresses

Application of prestressing of roof members- floor systems- Wall panels- hipped plate and shell structures- Large panel constructions – Columns – Shear walls.

Joints for different structural connections- Beam to Column, Beam to Beam, Column to Column, Column to Foundation, Connections between wall panels, Connections between floor panels - Design of expansion joints- Jointing Materials.

Production, Transportation and erection- shuttering and mould design – Dimensional tolerances- Design and detailing of prefabricated units

References

1.	Hass, A.M., Precast Concrete Design and Applications, Applied Science Publishers, 1991
2.	Promyslolw, V., Design and Erection of Reinforced Concrete Structures, MIR Publishers Moscow, 1980
3.	Gerostiza C.Z., Hendrikson C. and Rehat D.R., Knowledge Based Process Planning 76 for Construction and Manufacturing, Academic Press Inc., 1980
4.	Bauverlag, GMBH, 1971. 3. Structural Design Manual, Precast Concrete Connection Details, Society for the Studies in the Use of Precast Concrete, Netherland Betor Verlag, 1978.
5.	M. Levitt, “Precast Concrete Material, Manufacture, Properties and Usage” Applied Science Publishers Ltd., 1982.
6.	A.S.G. Bruggeling and G.F.Huyghe, Prefabrication with concrete, Netherlands: A.A. Balkema Publishers, 1991.
7.	Elliot K. M., Precast Concrete Structures, A Butterworth-Heinemann,
8.	Handbook on Precast Concrete Structures, Indian Concrete Institute, 2016
9.	PCI Design Handbook, 8th edition, Precast/Prestressed Concrete Institute, 2017

Course Outcomes (CO)

At the end of the course student will be able

CO1	To understand the behaviour of prefabricated structures
CO2	To become familiar with the production of prefabrication units and erection process.
CO3	To be able to perform an industry relevant design project in a team setting
CO4	To exhibit their knowledge in designing and detailing of prefabrication structural units
CO5	To be able to supervise the production, transportation and erection process of the prefabricated structural units

CEPE69 HERITAGE STRUCTURES

Course Code	**:**	CEPE69
Course Title	**:**	**Heritage Structures**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC14
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To study the terminologies and criteria for heritage structure
CLO2	To know the salient features and grading of heritage structures
CLO3	To study the preservation techniques of various heritage structures
CLO4	To create awareness on the adaptive reuse of heritage structures
CLO5	To get into more case studies on the protected heritage structures

Course Content

Introduction-terminologies- history of conservation- methodology and criteria for listing heritage structure

Grading of heritage structures- model building bye-laws - salient features and mapping of historic settlements

Factors deteriorating heritage structures- conservation and preservation techniques

Conservation projects - heritage conservation and adaptive reuse of heritage structures

Protected sites and monuments - case studies

References

1.	Handbook of conservation of heritage buildings - A Guide (2013) published by Directorate General, CPWD, NewDelhi.
2.	Effect of vibrations of historic buildings: An overview (1982) by J.H. Rainer,
3.	Maintaining and Repairing Old and Historic Buildings. Wiley-Blackwell by Cullinane,

	J. J. (2012).
4.	Conservation of Historic Buildings. London: Routledge by Feilden, B. M. (2003).
5.	A Richer Heritage: Historic Preservation in the Twenty-first Century. North Carolina: The University of North Carolina Press by Stipe, R.E. (2003).

Course Outcomes (CO)

At the end of the course student will be able

CO1	To attain in-depth knowledge on various terminologies and methodology involved for heritage structure.
CO2	To familiarise the features and building bye-laws
CO3	To visualise the correct preservative measures and methodology
CO4	To attain in-depth knowledge about the adaptive reuse of heritage structures
CO5	To familiarise about the various construction techniques Involved From the collected case Studies

CEPE70 EARTHQUAKE RESISTANT STRUCTURES

Course Code	**:**	CEPE70
Course Title	**:**	**Earthquake Resistant Structures**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC18, CEPC24
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce the basics of Earthquake Engineering
CLO2	To understand the effect of earthquake load on structural system dynamics
CLO3	To introduce tips on earthquake engineering - do's and don'ts
CLO4	To introduce cyclic loading behaviour of RC, steel and pre-stressed concrete elements
CLO5	To discuss code provisions and their application on different types of structures

Course Content

Elements of Engineering Seismology - Theory of Vibrations -Indian Seismicity - Earthquake History - Behavior of structures in the past Earthquakes.

Seismic Design Concepts - Cyclic loading behavior of RC, Steel and Prestressed Concrete elements - Response Spectrum- Design spectrum - capacity based design.

Provision of Seismic Code frames, shear walls, Braced frames, Combinations - Torsion.

Performance of Regular Buildings 3D Computer Analysis of Building Systems (Theory only) - Design and Detailing of frames - Shear walls and Frame walls.

Seismic performance - Irregular Buildings -Soil performance, Modern Concepts - Base

Isolation - Adoptive systems - Case studies.

References

1.	Pankaj Agarwal and Manish ShriKhande, Earthquake Resistant Design of Structures, Prentice- Hall of India, New Delhi, 2003.
2.	Bullen K.E., Introduction to the Theory of Seismology, Great Britain at the University Printing houses, Cambridge University Press 1996.
3.	S. K. Duggal; Earthquake Resistance Design of Structures; Oxford University Press, New Delhi
4.	Dynamics of Structures by A.K.Chopra, 3rd Edition, Person Education, 2007.
5.	IS:1893 (Pt1) 2016, Criteria for earthquake resistant design of structures, Bureau of Indian Standards, New Delhi.
6.	IS 13920 2016- Ductile detailing of reinforced concrete structures subjected to seismic forces - Code of practice. Bureau of Indian Standards, New Delhi.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	apply the basics of Earthquake Engineering
CO2	demonstrate the dynamics of structural system under earthquake load
CO3	analyze the influence of the structural / geometrical design in building characteristics
CO4	demonstrate the cyclic loading behaviour of RC steel and pre-stressed concrete elements
CO5	apply Codal provisions on different types of structures

CEPE71 STEEL CONCRETE COMPOSITE STRUCTURES

Course Code	**:**	CEPE71
Course Title	**:**	**Steel Concrete Composite Structures**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC18, CEPC24
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce the concept of steel concrete composite design and construction in civil engineering
CLO2	To discuss shear connector types, degree of shear connector, theeir interaction and the design of composite beams under propped and un- propped condition
CLO3	To introduce design of different types of composite deck slabs
CLO4	To introduce the design of composite columns under axial load and bending moments
CLO5	To discuss effects of temperature, shrinkage and creep on composite sections

Course Content

Introduction – history – mechanism of composite action – comparison – applications - limit states of composite sections – introduction to plastic analysis.

Shear connectors – types of shear connectors – degree of shear connection – partial and complete shear connections – strength of shear connectors – experimental evaluation of shear connectors.

Analysis and design of composite beams without profile sheet - propped condition – un-propped condition – deflection – design of partial shear connection. Design of composite beam with profile sheet – propped and un-propped condition – deflection of composite beams – design of partial shear connection.

Introduction – Composite slabs – profiled sheeting – sheeting parallel to span – sheeting perpendicular to span – analysis and design of composite floor system – floor vibration. Introduction – types of composite columns – design of concrete encased column – design of concrete infilled column – development of P-M interaction curve.

Effect of temperature loads on composite action – creep and shrinkage of concrete on composite design and construction

References

1.	Johnson R.P., “Composite Structures of Steel and Concrete”’ Volume-I, Black Well Scientific Publication, U.K., 1994
2.	Teaching Resources for “Structural Steel Design”. Vol.2 of 3, Institute of Steel Development and Growth (INSDAG), 2000
3.	Narayanan R., “Composite Steel Structures – Advances, Design and construction, Elsevier, Applied Science, U.K., 1987
4.	Owens, G.W & Knowles, P., Steel Designers Manual,” (fifth edition), Steel Concrete Institute (U.K), Oxford Blackwell Scientific Publication, 1992.
5.	IS 11384 – 1985 Indian Standard Code of Practice for Composite Construction in Structural Steel and Concrete, Bureau of Indian Standards, New Delhi

Course Outcomes (CO)

At the end of the course student will be able

CO1	Apply the concepts of steel concrete composite in civil engineering construction and practices.
CO2	Analyse the behavior of shear connectors, degree of shear connection and development of composite action.
CO3	Design composite beams under propped and un-propped condition.
CO4	Design different types of composite deck slabs and columns.
CO5	Analyse the effects of temperature, shrinkage and creep on composite design.

CEPE72 METALLURGY FOR CIVIL ENGINEERS

Course Code	**:**	CEPE72
Course Title	**:**	**Metallurgy for Civil Engineers**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC24
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To teach civil engineering students the solid and phase diagrams
CLO2	To make students understand the various microstructures of steel under room temperature
CLO3	To motivate students to learn the effects of alloying and the possibility of developing green steel
CLO4	To teach the effect of grain size on the mechanical properties of metal
CLO5	To make the students understand various types of stainless steel

Course Content

Introduction – Metallurgy for non-metallurgists – pure iron – solution and phase diagrams – Steel and Iron-carbon phase diagrams

The various microstructures of room temperature steel – Hypo and hypereutectoid steel – microstructure of quenched steel – spheroidized microstructures – mechanical properties

Low alloy AISI steel– Manganese in steel – effect of alloying elements – diffusion mechanism of atom migration within the metal – carburizing and decarburizing - green steel

Control of grain size by heat treatment and forging – new grains formed by phase transformation and recrystallization – Hardenability of steel

Tempering – Austenitization – Quenching – Stainless steels – Ferritic, Martensitic, Austenitic – Tool steels – Solidification – Cast irons

References

1.	John D. Verhoeven, Steel Metallurgy for the non-metallurgist, ASM International, 2007
2.	Totten G. E., Steel heat treatment: Metallurgy and Technologies, Marcel Dekker, 2006
3.	Meyrick G., Wagoner R.H., Steel class notes and lecture materials for MSE 651.01 physical metallurgy of steel
4.	Academy lecture notes on Concepts and basis of steel metallurgy, Arcelor Mittal

Course Outcomes (CO)

At the end of the course student will be able

CO1	To understand the importance of metallurgy for civil engineers
CO2	To choose the correct type of materials, welding process and welding consumables in steel construction
CO3	To familiarize with the various microstructures of steel under room temperature
CO4	To learn the role of alloying metals and grain size in the mechanical properties of

	steel
CO5	To know the types of stainless steel and the possibility of making green steel

CEPE73 BASIC BRIDGE ENGINEERING

Course Code	**:**	CEPE73
Course Title	**:**	**Basic Bridge Engineering**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC18, CEPC24
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn the components of bridges, classification of bridges, importance of bridges
CLO2	To study the specification of road bridges, loads to be considered
CLO3	To familiarize students with various types of concrete bridges such as slab-bridge, T-beam bridge
CLO4	To familiarize students with various types of steel bridges such as truss bridge and girder bridge and also railway bridges by IRS loadings
CLO5	To get exposure the substructure of bridge substructures and the evaluation and importance of bearings

Course Content

Components of Bridges - Classification - Importance of Bridges - Investigation for Bridges - Selection of Bridge site - Economical span - Choice of bridge type.

Specification of road bridges - width of carriageway - loads to be considered - dead load - IRC standard live load and IRS loading - Impact effect.

General design considerations - Concrete bridges - Slab Bridge - Design of T - beam bridge (superstructure only)

Steel bridges - truss bridge - plate girder bridge (superstructure only)

Importance of Bearings - Bearings for slab bridges - Bearings for girder bridges - Electrometric bearing - Joints - Expansion joints - substructure (theory only): piers, pier caps, types of foundations, piles and pile caps.

Note: Assignments include the design and drawings of bridge superstructures.

References

1.	Ponnuswamy, S., Bridge Engineering, Tata McGraw –Hill, New Delhi, 1997
2	Victor, D. J., Essentials of Bridge Engineering, Oxford andIBH Publishers Co., New Delhi, 1980
3	N. Rajagopalan, Bridge Superstructure, Narosa Publishing House, New Delhi, 2006.

4	Rangwala, Bridge Engineering, Charotar Publication, Anand, India, 2015
5	Raju N. K., Design of Bridges, Oxford andIBH Publishers Co., New Delhi, 2019

Course Outcomes (CO)

At the end of the course student will be able

CO1	To be familiar with the components of bridges, classification of bridges, importance of bridges
CO2	To understand the specification of road bridges, loads to be considered
CO3	To be familiar with various types of concrete bridges such as slab-bridge, Tbeam bridge, prestressed concrete bridge
CO4	To be familiar with various types of steel bridges such truss bridge and girder bridge
CO5	To get exposed to evaluation of sub structures, type of foundations, importance of bearings

CEPE74 ADVANCED MECHANICS OF SOLIDS

Course Code	**:**	CEPE74
Course Title	**:**	**Advanced Mechanics of Solids**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC10, CEPC14
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn the elastic and plastic behaviour of materials
CLO2	To understand principal stresses and Mohrs circles in 3D
CLO3	To get exposed to unsymmetrical bending of beams
CLO4	To familiarize with the analysis of curved beams
CLO5	To know the fundamentals of vibration and resonance

Course Content

Mechanical Properties of Materials - Stress-Strain Diagrams- Elastic and Plastic Deformation - Brittle and Ductile Failures of Materials - Mechanical Tests like Surface Hardness, Fatigue, Creep etc.

Principal stresses in a 3D field.- Computation -Mohr's Circle - Lame's Ellipsoid. Theories of failure - Criteria for Failure - Different failure theories for ductile and brittle materials. Equivalent bending and twisting moments.

Unsymmetrical bending- Properties of unsymmetrical sections- Stresses and deflection due to unsymmetrical bending

Shear Centre - Concept and significance - Shear flow for thin walled open sections- Location of shear centre for singly symmetric sections.

Stresses in curved flexural members-Winkler Bach Formula - Crane hooks - rings and links.

Fundamentals of vibration - free vibration of single degree of freedom systems - Undamped and damped free vibration with different types of damping.- Resonance-Harmonic response of single degree of freedom systems with and without damping.

References

1	L S Srinath, Advanced Mechanics of Solids, Tata McGraw Hill, 2017
2	A. P. Boresi, R. J. Schmidt, Advanced Mechanics of Materials, Wiley, 2021
3	A. P. Boresi, K. P. Chong, Elasticity in Engineering Mechanics, Wiley-Interscience, 2000

Course Outcomes (CO)

At the end of the course student will be able

CO1	Characterize the elastic and plastic behaviour of materials
CO2	Draw Mohrs circle for 3D stress states
CO3	Find the stresses and deflections in unsymmetrical loaded beams
CO4	Find the stresses and deflections in curved beams
CO5	Solve fundamental problems in vibrations of SDOF systems

CEPE75 OPTIMISATION TECHNIQUES IN CIVIL ENGINEERING

Course Code	**:**	CEPE75
Course Title	**:**	**Optimisation Techniques in Civil Engineering**
Type of Course	**:**	PE
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	Classify different types of optimization problems and apply geometric, graphical, and analytical methods for solving them
CLO2	Learn and apply various single variable unconstrained optimization techniques
CLO3	Develop proficiency in multivariable unconstrained optimization techniques
CLO4	Understand the principles and applications of linear programming in civil engineering
CLO5	Analyze and solve real-world optimization problems in civil engineering, demonstrating the practical utility of optimization methods

Course Content

Introduction to optimization methods - optimization problem formulation - objective function, constraints. Classification of optimization problems. Geometric, graphical, analytical methods of optimization. Application examples from engineering.

Single Variable Unconstrained Optimisation Techniques - Optimality Criteria. Kuhn-Tucker

conditions. Bracketing methods. Region Elimination methods. Interpolation methods. Gradient Based methods: Newton-Raphson method, Secant method.

Multivariable Unconstrained Optimisation Techniques- Optimality Criteria- Unidirectional Search. Direct Search methods: Random search, Grid search, Powell's conjugate direction method, Simplex method. Gradient based methods: Cauchy's (Steepest descent) method, Conjugate gradient (Fletcher Reeves) method, Newton's method, DFP and BFGS method.

Linear programming, simplex method- dual problem, weak duality theorem, optimality criterion theorem, main duality theorem, complementary slackness theorem, primal-dual relationship, economic interpretation of dual solution, introduction to sensitivity analysis examples of applications of linear programming in engineering..

References

1	Rajasekharan S. "Numerical Methods in Science and Engineering" S Chand & company 2003.
2	S.S. Rao, Optimisation Theory and applications, Wiley Eastern.
3	Belegundu., Optimisation concepts and Applications Engineering.
4	S. S. Rao, Engineering Optimization, New Age International (P) Ltd. Publishers.
5	J. S. Arora, Introduction to Optimum Design, McGraw-Hill Book Company.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Formulate engineering design problem as an optimization problem.
CO2	Apply suitable optimization technique to the design problem at hand.
CO3	Evaluate the problem as linear or nonlinear optimization problem and design the optimization technique.
CO4	Evaluate the problem as single variable or multi-variable optimization problem and design the corresponding optimization technique
CO5	Formulate linear programming problem for engineering applications and evaluate the solution.

CEPE76 INTRODUCTION TO FINITE ELEMENT METHODS

Course Code	**:**	CEPE76
Course Title	**:**	**Introduction to Finite Element Methods**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC10, CEPC15
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	Understand the basic concepts and mathematical modeling techniques used in finite element analysis

CLO2	Master the definitions and basic operations of finite elements, such as nodes, degrees of freedom (dof), local and global axes, and interelement equilibrium and compatibility
CLO3	Apply basic equations of elasticity to analyze structural problems, including rotations versus displacements, equations of equilibrium, and strain-displacement relations
CLO4	earn and implement the direct stiffness method for global analysis in FEA, including the basic concepts and general procedures
CLO5	Understand and apply the concept of isoparametric formulations for plane rectangular elements

Course Content

Introduction: Basic concepts of FEA, mathematical modeling of physical systems, exact and approximate methods, background of the development of FEA with emphasis on stress analysis context.

Definitions and basic element operations: Node, degrees of freedom (dof), local or element axes, global axes, interelement equilibrium and compatibility, element force vs displacement relations, flexibility formulation, stiffness formulation, flexibility - stiffness transformations

Element transformation matrices (element global transformations): transformation of dof and transformed stiffness relations - truss element, plane frame element, and condensation of dof.

Global analysis procedure: Direct - Finite element formulations: formulation of element force - displacement relations

Variational method of element formulation – Method of weighted residuals - Representation of element functions for behaviour and geometry – polynomial functions for 2D and 3D rectangular elements, direct construction of shape functions through interpolation - Lagrangian interpolation in natural coordinates- Hermitian interpolation

Isoparametric formulations: Concept - plane rectangular elements Jacobian-numerical integration

References

1	Gallaghar, R.H., Finite Element Analysis: Fundamentals, Prentice Hall Inc, 1975.
2	Bathe, K.J., Finite Element Procedures in Engineering Analysis, Prentice Hall of India, 1996.
3	Cook, R.D., et al, Concepts and Applications of Finite Element Analysis, John Wiley, 2007
4	Rajasekaran, S., Finite Element Analysis in Engineering Design, Wheeler Pub, 2008
5	Zienkiewicz, O.C., and Taylor, R.L., The Finite Element Method, Vol. I and II, McGraw Hill, 2000

Course Outcomes (CO)

At the end of the course student will be able

CO1	Demonstrate a comprehensive understanding of the basic concepts of finite element analysis (FEA) and its development, with a particular emphasis on stress analysis.
CO2	Formulate and transform element force-displacement relations using flexibility and stiffness methods, and understand transformations between flexibility and stiffness
CO3	Execute the direct stiffness method, including its basic concepts and general procedures, for global analysis in FEA
CO4	Formulate element force-displacement relations using the direct method and variational principles
CO5	Develop and utilize element behavior functions, including polynomial series for 2D rectangular elements, and construct shape functions through interpolation using natural coordinates

CEPE77 STRUCTURAL HEALTH MONITORING

Course Code	**:**	CEPE77
Course Title	**:**	**Structural Health Monitoring**
Type of Course	**:**	PE
Prerequisites	**:**	CELR13
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	Understand systems and sensors for health monitoring of structures
CLO2	Gain knowledge on different type of sensors and data acquisition systems
CLO3	Gain knowledge of the static and dynamic measurement techniques
CLO4	Carry out different damage detection techniques for health monitoring of structures
CLO5	Use the IoT and machine learning concepts for health monitoring of structures

Course Content

Introduction to structural health monitoring (SHM): Need for SHM, SHM versus Non-Destructive Evaluation, Methods of SHM, Local & Global Techniques for SHM, Short & Long-Term Monitoring, Active & Passive Monitoring - Remote SHM – IoT applications in SHM – Machine leaning Techniques in SHM.

Sensors for measurements– Data Acquisition Systems – Data Transmission – Data Processing – Storage of processed data

Measurement and damage detection techniques: Static measurement - Dynamic measurement - Damage diagnostic methods based on vibrational response and wave propagation – Neural network-based classification techniques - connectionist algorithms for anomaly detection, multiple damage detection

Data processing and case studies: Signal processing methods – Practical aspects of testing large bridges for structural assessment – Optimal placement of sensors – Structural

integrity and condition monitoring of aging multistorey buildings.

References

1	Daniel Balageas, Peter Fritzen, Alfredo Guemes, Structural Health Monitoring, John Wiley & Sons, 2006.
2	Douglas E Adams, Health Monitoring of Structural Materials and Components Methods with Applications, Wiley Publishers, 2007
3	Hua-Peng Chen, Structural Health Monitoring of Large Civil Engineering Structures, Wiley Publishers, 2018
4	Ansari, F Karbhari, Structural health monitoring of civil infrastructure systems, V.M. Woodhead Publishing, 2009
5	Victor Giurglutiu, — Structural Health Monitoring with Wafer Active Sensors, Academic Press Inc, 2007

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Demonstrate a comprehensive understanding of the basic principles of SHM.
CO2	Identify and apply the appropriate sensors and instrumentation for various SHM applications
CO3	Execute static and dynamic measurement techniques to detect and assess structural damage effectively
CO4	Employ advanced signal processing methods to process SHM data, and analyze the structural integrity of various infrastructures
CO5	Critically analyze case studies involving the SHM of large-scale structures, optimize sensor placement, and develop strategies

CEPE78 INTRODUCTION TO MATRIX METHOD OF STRUCTURAL ANALYSIS

Course Code	**:**	CEPE78
Course Title	**:**	**Introduction to Matrix Method of Structural Analysis**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC15
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Outcomes

CLO1	Basic understanding about direct stiffness method
CLO2	Accurately derive and assemble local and global stiffness matrices for different structural elements (e.g., beams, trusses, frames)
CLO3	Apply matrix methods to solve systems of equations for determining displacements, forces, and reactions in various structural systems
CLO4	Perform matrix-based analysis of trusses and frames, addressing the effects of loads, supports, and boundary conditions
CLO5	Effectively utilize structural analysis software to model, analyze, and interpret the behavior of real-world structural systems

Course Content

Introduction and basic concepts: Types of structures (beams, frames, trusses), Loads

and support conditions, Traditional methods vs. matrix method, Flexibility vs Stiffness method,

Fundamentals of Matrix Algebra: Definitions and types of matrices, Matrix operations, Transpose, inverse, and determinant, Gaussian elimination, Matrix representation of linear systems, Diagonal, symmetric, and orthogonal matrices

Structural Systems and Matrix Formulation: Degrees of freedom, Nodal displacements and member forces, Global and local coordinate systems, Stiffness matrices for individual members, Method of superposition, Coordination of local matrices into global matrix, Direct Stiffness method

Analysis of Plane Truss, Beams and 2-D Frames*:* Truss element stiffness matrices, Flexural stiffness and deformation, Element stiffness matrices for beam and Frame, Transformation and assembly of element matrices, Incorporation of boundary conditions, Solving linear systems for Nodal displacement and Member force calculations

Computer Applications and Software: Overview of popular software (e.g., SAP2000, ETABS, ANSYS), solving case studies and example problems.

References

1	Aslam Kassimali, Matrix Analysis of Structures
2	E. J. McGuire, R. H. Gallagher, and R. D. Ziemian, Matrix Structural Analysis
3	K. H. Hsu**, Introduction to Matrix Methods of Structural Analysis**
4	John L. Meek., Matrix Structural Analysis
5	R.C. Hibbeler, Structural Analysis

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Understand and apply basic matrix algebra to structural analysis problems.
CO2	Develop and assemble local and global stiffness matrices for structural elements like beams, trusses, and frames.
CO3	Solve systems of linear equations to find displacements, member forces, and support reactions in structures.
CO4	Apply matrix methods to analyze trusses and frames, accounting for various forces and support conditions.
CO5	Use structural analysis software to analyse and interpret real-world structural problems.

STREAM VII: WATER RESOURCES ENGINEERING

CEPE80 GROUNDWATER HYDROLOGY

Course Code	**:**	CEPE80
Course Title	**:**	**Groundwater Hydrology**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC12
Contact Hours	**:**	36

Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To know different types of aquifers
CLO2	To understand the surface and subsurface investigation in detail
CLO3	To integrate the fundamental and basic knowledge of ground water movement
CLO4	To understand the process of sea water intrusion and recharge
CLO5	To introduce the different model studies

Course Content

Groundwater occurrence – distribution – aquifer – types - Surface investigation - Geophysical - electrical resistivity - Seismic refraction - Gravity and magnetic - Geologic - Air photo interpretation - Dowsing.

Subsurface investigation - test drilling - resistivity logging- potential logging - temperature and caliper logging.

Steady unidirectional flow - well in a uniform flow - steady flow with uniform recharge - unsteady radial flow to a well - well flow near aquifer boundaries - Multiple well systems - partially penetrating wells - characteristic well losses.

Secular and seasonal variations - Fluctuations due to evapo-transpiration, Meteorological phenomena, tides, external loads and earthquakes - control by drains and wells. Recharge through sewage pits, shafts and wells.

Occurrence of sea water intrusion - Ghypon-Heizberg relation between fresh and saline waters - shape length and structure of the fresh salt water interface – prevention and control of seawater intrusion - role of sea water in ground water - coastal zoning.

Sand models - Electrical models - Viscous fluid models - membrane models - numerical analysis methods

References

1.	*Raghunath H.M., Ground Water Hydrology, New-Age International, 2nd Edition, 1990.*
2.	*Todd, D.K, Ground Water Hydrology, Prentice hall, 2004*

Course Outcomes (CO)

At the end of the course student will be able

CO1	Identify types of aquifers
CO2	carry out surface and subsurface investigation to locate groundwater
CO3	visualise the occurrence and movement of groundwater
CO4	select suitable type of ground water recharge
CO5	Assess sea water intrusion and its control

CEPE81 APPLIED HYDRAULICS ENGINEERING

Course Code	**:**	CEPE81
Course Title	**:**	**Applied Hydraulics Engineering**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC12
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To classify the types of flows in open channel and also to design open channel sections in a most economical manner.
CLO2	To study about non uniform flows in open channel and longitudinal slopes in open channel and also to learn about the characteristics of hydraulic jump.
CLO3	To develop an understanding of fluid flow patterns and learn to use boundary layer theory and Drag.
CLO4	To Provide insights to the Open channel hydraulics and introduce dimensional analysis for fluid flow problems.
CLO5	To understand the flow profiles and different methods of profile determination.

Course Content

Open channel flow and its classifications, and properties, energy and momentum principles, Critical flow computation and its applications, transitions with sub critical and super critical flows. Types and regimes of flow – Velocity distribution in open channel – Wide open channel

Design of non- erodible channels for uniform flow, most efficient channel section, compound Sections. Velocity measurement – Manning's and Chezy's formula – Determination of roughness coefficients – Determination of normal depth and velocity. Gradually varied flow: Theory and analysis, gradually-varied flow computations in prismatic channels, gradually varied flow in non-prismatic channels. Characteristics of flow profiles –

Draw down and back water curves – Profile determination – Graphical integration, direct step And standard step method – Flow through transitions

Rapidly varied flow- Theory of hydraulic jump, evaluation of jump elements in rectangular and non-rectangular channel, location of jump on horizontal floor, channel controls and transition – surges

Boundary Layer Theory: Introduction, Development of boundary layer over a flat plate, boundary layer thickness, displacement, momentum and energy thicknesses, Application of momentum equation to boundary layer flow, local and mean drag coefficients.

References

1.	Streeter, V.L. Fluid Mechanics, Tata McGraw Hill, 1998.
2.	Chow, V.T. Open Channel Hydraulics, Tata McGraw Hill, 1975.

3.	Nagaratnam, S. Fluid Mechanics, Khanna Publishers, 1989.
4.	Chaudhry, M and Hanif. Open Channel Flow. Englewood Cliffs, NJ: Prentice- Hall, 1993.
5.	Chanson, H (2004b).The Hydraulics of Open Channel Flow-An Introduction, (Butterworth-Heinemann, Oxford, UK) 2ndEdition (ISBN 07506 59785).

Course Outcomes (CO)

At the end of the course student will be able

CO1	Acquire specific knowledge regarding fluid flow phenomena observed in Civil Engineering systems such as flow in open channel flow
CO2	Develop understanding of the basic principles of fluid flow patterns and boundary layer theory and provide skills in analyzing fluid flows in open channel hydraulics
CO3	Understand gradually varied flow profile in detail.
CO4	Understand rapidly varied flow profile in detail
CO5	Knowledge is useful for the design of open channels for rectangular and non-rectangular channels for hydraulic jump phenomena.

CEPE82 SIMULATION MODELLING FOR WATER RESOURCES ENGINEERING

Course Code	**:**	CEPE82
Course Title	**:**	**Simulation Modelling for Water Resources Engineering**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC12
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To build on the student's background in basics of simulation modelling.
CLO2	To develop the skills in modelling of linear and nonlinear regression.
CLO3	To learn about dynamic programming techniques for water allocation and distribution networks.
CLO4	To develop skills in the artificial intelligence tools such as fuzzy systems, neural networks and genetic programming.
CLO5	To provide wide knowledge on optimization tools.

Course Content

Introduction – Concepts of systems and systems Analysis; Systems Techniques in Water Resources: Optimization with methods using calculus.

Regression – linear regression - multiple regression – non linear regression – types – modelling concepts – Probabilistic functions in hydrology- Monte Carlo simulation - Linear Programming- simplex method – dual simplex method - graphical method.

Dynamic programming – forward recursion – backward recursion – water allocation problem – shortest path algorithm – water distribution network – stochastic dynamic programming.

Artificial Intelligence – Neural networks – concepts – back propagation – bias, neuron, weights - radial basis function – case studies – Genetic algorithm – ANN- basics.

Optimization tool- roulette wheel selection – mutation – crossover- case studies Reservoir optimization – Fuzzy inference system – Fuzzy linear programming.

References

1.	Chintalacheruvu Madhusudana Rao, Advanced Modelling and Innovations in Water Resources Engineering, Volume 176 of Lecture Notes in Civil Engineering, Springer Nature, 2021
2.	Richard H. McCuen, Hydrologic Analysis and Design, Pearson Education, 2016
3.	Russell & Norvig, Artificial Intelligence: A Modern Approach, Global Edition, 4, Pearson Higher Ed, 2021
4.	Dimitri Bertsekas, Dynamic Programming and Optimal Control: Volume II; Approximate Dynamic Programming, Athena Scientific, 2012
5.	Terano, Asai & Sugeno Applied Fuzzy Systems, Academic Press, 2014

Course Outcomes (CO)

At the end of the course student will be able

CO1	Incorporate skills in developing models for various systems.
CO2	Acquires knowledge on fundamentals of regression techniques.
CO3	Develops and improves the knowledge of dynamic programming and stochastic programming.
CO4	Apply neural networks and genetic algorithms for solving complex problems using AI techniques.
CO5	Provides basic knowledge on fuzzy system and optimization tools.

CEPE83 COASTAL ENGINEERING

Course Code	**:**	CEPE83
Course Title	**:**	**Coastal Engineering**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC12
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To provide basic knowledge on two dimensional wave equation
CLO2	To describe the various types of wave theories.
CLO3	To study the effect of wave loads on different coastal structures

CLO4	To understand sediment transport and coastal morphology
CLO5	To acquire skills in planning, designing, and evaluating coastal protection structures

Course Content

Basic Fluid Mechanics: Conservation of mass and momentum, Euler Equation, Bernoullis equation, potential flow, stream function. Waves: Classification of water waves - Two dimensional wave equation and wave characteristics.

Indian Scenario – Classification of Harbours. Introduction - wind and waves – Sea and Swell -Introduction to small amplitude wave theory – use of wave tables- Mechanics of water waves – Linear (Airy) wave theory, Introduction to Tsunami

Wave theories - Small amplitude waves – Finite amplitude waves - Stoke, Solitary and CnoidalWater particle kinematics - wave refraction; wave breaking; wave diffraction random and 3D waves- Short term wave analysis – wave spectra and its utilities - Long term wave analysis- Statistics analysis of grouped wave data – Currents: Classification - Behaviour - Design Criteria, Scour and other effects of currents

Dynamic beach profile; cross-shore transport; along shore transport (Littoral transport), sediment movement – Estuaries – Creek – Harbour – Littoral drift.

Field measurement; models, groins, sea walls, offshore breakwaters, artificial beach nourishment - planning of coast protection works - Design of shore defense structures – Case studies.

References

1.	Subratakumar Chakrabarti, Handbook of offshore engineering, Volume 1, Elsevier, 2005
2.	Coastal, Estuaries and Harbour Engineer's reference book, Michael Abbott, W Alan Price, CRC Press, 1993
3.	Coastal Engineering Manual, U. S. Army Corps of Engineers, Books Express Publishing, 2012
4.	Mani J.S, Coastal Engineering, Second Edition, PHI Learning Pvt. Ltd., 2018
5.	Leo H. Holthuijsen, Waves in Oceanic and Coastal Waters, Cambridge University Press, 2007

Course Outcomes (CO)

At the end of the course student will be able

CO1	Develop knowledge in basics of wave hydrodynamics
CO2	Provides understanding various aspects of coastal engineering
CO3	Describes wave forces, wave pressures and currents in the coastal areas.
CO4	Improves knowledge on sea defence structures
CO5	Develop knowledge in basics of wave hydrodynamics

CEPE84 SURFACE WATER HYDROLOGY

Course Code	**:**	CEPE84
Course Title	**:**	**Surface Water Hydrology**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC12
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To explain the hydrological cycle and significance, analysis of precipitation.
CLO2	To describe the process of evaporation, evapotranspiration, infiltration, and its measurement techniques.
CLO3	To apply the methods for accurate streamflow, runoff estimation.
CLO4	To apply hydrograph theory to perform hydrograph analysis.
CLO5	To apply different methods for flood frequency analysis, and implement flood routing techniques to evaluate risk and reliability in flood management.

Course Content

Introduction to hydrology, hydrological cycle, history of hydrology, water budget equation, precipitation, forms and characteristics of precipitation, measurement and collection of precipitation data, rain gauge network, estimation of missing precipitation data, test for consistency and continuity of data, mean precipitation over an area, depth-area-duration analysis, intensity-duration-frequency curve, probable maximum precipitation.

Hydrologic abstractions, interception and depression storage, evaporation process, estimation, evapotranspiration, measurement, infiltration process, infiltration indices.

Streamflow measurement, runoff, characteristics and components of runoff, factors affecting runoff, runoff volume, SCS-CN method.

Hydrograph analysis, flood hydrograph, factors affecting hydrograph, components of hydrograph, base flow separation, unit hydrograph theory and application, method of superposition, S-curve, synthetic unit hydrograph, instantaneous unit hydrograph.

Flood Analysis, rational method, empirical formulas, flood frequency analysis: Gumbel's distribution, risk and reliability, flood routing.

References

1.	Subramanya K., "Hydrology,Tata McGraw Hill Co., New Delhi, 1994.
2.	Patra.K.C, "Hydrology and Water Resources Engineering", Narosa Publications, 2008, 2 nd Edition, New Delhi.
3.	Jeya Rami Reddy.P, "Hydrology, Laximi Publications, New Delhi, 2004
4.	Chow, V. T., Maidment, D. R., Mays, L. W., Applied Hydrology, McGraw Hill, 1988.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	To understand the fundamental principles of hydrology and analyze the precipitation.
CO2	To understand the processes and significance of hydrologic abstractions in the hydrological cycle.
CO3	To apply techniques for streamflow measurement and analyze runoff characteristics and volume.
CO4	To develop, and analyze the components of hydrographs using various methods.
CO5	To conduct flood frequency and apply flood routing techniques for flood analysis.

CEPE85 AI/ML FOR WATER RESOURCES ENGINEERING

Course Code	**:**	CEPE85
Course Title	**:**	**AI/ML for Water resources Engineering**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC12
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn the basics of AI and its use in civil engineering.
CLO2	To study the structure and learning processes of artificial neural networks (ANN).
CLO3	To understand genetic algorithms and their applications in water management.
CLO4	To learn about fuzzy logic and its applications in civil engineering.
CLO5	To study machine learning and the Internet of Things (IoT) for water resource management.

Course Content

Artificial Neural network and Application of ANN in water Resource-Artificial Intelligence (AI)-Definition-Development of AI-Types of AI-Application of AI of Civil Engineering-Uncertainty and towards Learning Systems-Optimisation –AI techniques. Artificial Neural Networks-Basics of ANN–Topology-Learning Processes-Supervised and unsupervised learning. Least mean square algorithm-Structural Properties-Feed forward ANN-Back Propagation-Advantages of ANN, Rainfall-runoff and stream flow prediction problems in ANN-Optimisation-ANN in Water Conservation

Genetic Algorithm (GA) - Introduction-Biological background-Genetic algorithm (GA) vs traditional algorithm-Basic Terminologies in GA Advantages and limitations of GA-Applications of GA-water distribution network- Scheduling-Irrigation planning.

Fuzzy logic and applications - Introduction of Fuzzy logic-Fuzzy sets-Fuzzy relations-Fuzzy rule and decision making-hybrid soft computing–Neuro fuzzy-Application of Fuzzy-

Durability of self-Compacting concrete-Reservoir operation-Neuro fuzzy application in Reservoir operations- Flood predictions.

Machine learning and its application - Introduction–Machine learning (ML) approaches-understanding pattern recognition-Advanced machine learning algorithm-machine learning applications-ML for Rainfall- runoff modeling, Flood prediction- Irrigation and crop-water demand predication.

Internet of Things (IoT) – Introduction - IoT Enabling Technologies-Domain Specific IoT-Smart agriculture -Water supply and pumping operation - Surveillance-Emergency response of dams-weather monitoring-Forest fire detection-River flood detection - Smart irrigation.

References

1	Gebrail Bekdaş, Sinan Melih Nigdeli and Melda Yücel, Artificial Intelligence and Machine Learning
2	Applications in Civil, Mechanical, and Industrial Engineering, 2019 IGI, global. Australia
3	Sivanandam S N and Deepa S N, Principles of Soft computing 2011, Second Edition, Wiley, USA
4	Arshdeep Bahga, Vijay Madisetti, Internet of Things: A hands on approach, 2015, University Press, UK
5	Stuart J. Russell and Peter Norvig Artificial Intelligence A Modern approach, 2015, Pearson, India
6	S M Yadav Application of soft computing techniques in Civil Engineering, 2018, MV learning, India

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Describe AI and its applications in civil engineering.
CO2	Implement ANN to solve water resource problems like rainfall prediction.
CO3	Apply genetic algorithms for optimizing water distribution and irrigation.
CO4	Use fuzzy logic for reservoir operations and flood predictions.
CO5	Use machine learning and IoT in smart irrigation and water supply systems.

CEPE86 HYDROCLIMATOLOGY

Course Code	**:**	CEPE86
Course Title	**:**	**Hydroclimatology**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC12
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand Learn atmospheric dynamics, global carbon cycle's history and dynamics, including non-CO2 greenhouse gases and the greenhouse effect.
CLO2	To analyze climate change scenarios, sensitivity, and human-climate change links using econometric models and GHG emissions estimates.
CLO3	To learn how climate change affects precipitation patterns, evaporation and transpiration, and surface and groundwater systems.
CLO4	To Use various models to project climate scenarios, calibrate, validate, and develop adaptation strategies.
CLO5	To Conduct risk assessments for floods and droughts, analyze rainfall trends, and evaluate sediment impacts on water resources.

Course Content

Climate change – historical perspectives cyclone - the Global Carbon Cycle, the Ocean Carbon Cycle, the Terrestrial Carbon Cycle, Modeling the Carbon Cycle- Non-CO2 Greenhouse Gases and Aerosols- Greenhouse Effect: Temperature, Radiation, & Energy,

Climate Scenarios - Developing climate models–Climate system model–Climate simulation and drift–Evaluation of climate model simulation–Regional (RCM)–Global (GCM)–Global average response to warming–Climate change observed to date. - Impacts of Climate Change- Climate change & policy options - IPCC details and actions –Kyoto protocol–Kyoto mechanisms, clean development mechanisms, Carbon credits-International and Regional cooperation.

Climate Change impacts on Hydrological Processes - Changes in precipitation patterns - Surface runoff, Extreme flow – Flash flood - Groundwater recharges and its Impacts - Temperature raise effects on evaporation and transpiration- Sea level raise and its impact – Drought.

Climate & Hydrological Models - Types of models (conceptual, empirical, physical)- Model calibration and validation- Climate Change Scenarios – down scaling - Incorporating climate projections in models - Scenario analysis and uncertainty- Adaptation Strategies - Sustainable water management - Infrastructure adaptation for climate resilience

Applications of Climate change on Hydrology and Water resource Flood and drought risk assessment – Rainfall trend, extreme and future trend of rainfall and temperature analysis – Sediment and reservoir volume assessment for future period - Real-world applications of climate change impact on hydrology and water resource.

References

1	Kevin E. Trenberth: Climate System Modeling, Cambridge University Press
2	Neelin David J, Climate Change and Climate Modelling, 2011, First Edition, Cambridge University Press,UK.
3	Thomas Stocker, Introduction to Climate Modelling, Advances in Geophysical and Environmental Mechanics and Mathematics. 2011, Springer, UK
4	Stephen Peak and Joe Smith, Climate Change: From science to sustainability, Oxford

	University Press
5	IPCC (1995) Climate Change 1995: The Science of Climate Change, Cambridge Niv Press, Cambridge, UK
6	Robert T. Watson, Marufu C. Zinyowera, Impacts, Richard H. Moss, Adaptation and mitigation of climate change-Scientific Technical Analyses, 1996, Cambridge University Press, Cambridge, USA

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Describe the carbon cycles, greenhouse gases, and greenhouse effects.
CO2	Develop and assess climate models, understanding their simulations and regional impacts.
CO3	Analyse the effects of climate change on precipitation, runoff, groundwater, and sea levels.
CO4	Use various models to project climate scenarios, calibrate, validate, and develop adaptation strategies.
CO5	Conduct risk assessments for floods and droughts, analyse rainfall trends, and evaluate sediment impacts on water resources.

CEPE87 RIVER ENGINEERING

Course Code	**:**	CEPE87
Course Title	**:**	**River Engineering**
Type of Course	**:**	PE
Prerequisites	**:**	CEPC12
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To develop the student's knowledge on basics of River engineering.
CLO2	To provide some knowledge about behaviour of Rivers.
CLO3	To develop understanding of River morphology.
CLO4	To make the student understand about unsteady flow in Rivers.
CLO5	To provide knowledge about River training works.

Course Content

Classification of Rivers, channel and flood plain features, sediment budgets, river morphology.

River channel patterns, causes, characteristics and prevention of meanders, cutoff characteristics, bed forms, delta form and control.

Bed level variation in alluvial streams, continuity equation for sediment, equilibrium depth of scour in long channel contractions, silting of reservoirs, local scour, secondary currents, flow in rigid boundary open channel bends, scour and deposition at alluvial bends.

Governing equations for one dimensional flow, hydrograph routing, kinematic routing, diffusion routing, Muskingum–Cunge routing.

Introduction to river training, types of river training works, working of different river training structures, protection bridge, guide bund, embankment and spurs.

References

1.	H. H. Chang, “Fluvial Processes in River Engineering”, Krieger Publishing Company, 1stEdition, 2008.
2.	W. Wu, “Computational River Dynamics”, Taylor & Francis, 1stEdition, 2007.
3.	P Y Julien River Mechanics, Cambridge university press, 2nd edition, 2018
4.	M. H. Chaudhry, “Open channel flow”, Springer, 2ndEdition, 2008.
5.	M. B. N. Al-BaghdadiK, “Progress in River Engineering & Hydraulic Structures”, Create Space Independent Publishing Platform, 1stEdition, 2018.
6.	M M Das Open channel flow, PHI, 3rd edition, 2011

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Understand the basics of River engineering.
CO2	Understand the concepts of River behavior.
CO3	Computer river morphology.
CO4	Understand the unsteady flow process in River.
CO5	Understand about different types of River training works.

CEPE88 WATERSHED MANAGEMENT

Course Code	:	CEPE88
Course Title	**:**	**Watershed Management**
Type Of Course	:	PE
Prerequisites	:	CEPC12
Contact Hours	:	36
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To define watershed and explain its role in hydrology, ecology, and urban planning.
CLO2	To discuss methods for controlling water quality and quantity, and evaluate and apply best management practices (bmps) for flood control and drought management.

CLO3	To identify causes and consequences of soil erosion, propose erosion control measures, and describe and implement water conservation techniques, including rainwater harvesting.
CLO4	To summarize key watershed management policies and regulations, and understand the roles and coordination of federal, state, and local agencies.
CLO5	To explore new technologies in watershed management and assess the impact of climate change on these practices.

Course Content

Watershed management: hydrological processes: basic hydrology: the hydrological cycle and its components. Hydrological data collection and analysis: definition and importance of watershed: significance of watershed management in civil engineering. The role of watersheds in hydrology, ecology, and urban planning. Components of a watershed: watershed boundaries and delineation. Types of watersheds. Characteristics of watershed.

Watershed management strategies: water quality and quantity control. Flood control and drought management. Best management practices (BMPS): structural BMPS. Non-structural BMPS. Watershed planning and implementation: steps in developing a watershed management plan. Stakeholder involvement and public participation.

Soil and water conservation: soil erosion: types of erosion, causes and consequences of soil erosion, soil loss models. Erosion control measures, sediment management. Water conservation techniques: methods for efficient water use and management. Rainwater harvesting and its applications.

Policy and regulatory framework: legal aspects: overview of watershed management policies and regulations. Key legislation related to water resources and environmental protection. Institutional framework: roles of various agencies and organizations in watershed management. Coordination among federal, state, and local authorities.

Emerging trends and technologies: innovations in watershed management: new technologies and methods in watershed management. The impact of climate change on watershed management practices. Case studies and applications.

References

1.	Chow, V.T. Handbook Of Applied Hydrology. Mc Graw-Hill, New York.
2.	Dutta, S.K. Soil Conservation And Land Management, International Book Distributors.
3.	Rattan, Lal. Soil Erosion In The Tropics: Principles And Management. Mcgraw-Hill.
4.	Wurbs, R.A. And James, W.P. Water Resource Engineering. Prentice Hall India Learning Private Limited.
5.	Brooks, K. N., Ffolliott, P. F., And Magner, J. A. Hydrology And The Management Of Watersheds. John Wiley & Sons.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	To describe the hydrological cycle, watershed components, and their roles in hydrology and urban planning.
CO2	To apply BMPs for water management and create a watershed management plan with stakeholder involvement.
CO3	To implement erosion control and water conservation practices to improve land and water management.
CO4	To comprehend and apply key watershed management policies, regulations, and the roles of various agencies.
CO5	To use new technologies in watershed management and address climate change impacts with adaptive strategies.

CEPE89 WATER RESOURCECS SYSTEMS PLANNING

Course Code	:	CEPE89
Course Title	**:**	**Water Resources Systems Planning**
Type Of Course	:	PE
Prerequisites	:	CEPC12
Contact Hours	:	36
Course Assessment Methods	**:**	**Continuous Assessment, End Assessment**

Course Learning Objectives (CLO)

CLO1	To know the concept of system analysis
CLO2	To get knowledge on optimisation techniques, concepts and types
CLO3	To learn the classical optimisation techniques and simulation techniques
CLO4	To get introduced in to various optimisation algorithms and decision-making criteria
CLO5	To solve reservoir optimisation problems by using various optimisation techniques.

Course Content

Overview of the course, concepts of systems analysis, water resources planning, Modelling techniques, objectives and constraints, overview of optimization techniques.

Linear programming, graphical method, simplex method, sensitivity analysis, duality. Dynamic programming, concepts, formulation of recursive equation.

Classical optimization techniques, Lagrange methods, Kuhn-Tucker conditions, Search techniques, Stochastic optimization techniques, chance constrained LP, stochastic dynamic programming, decision making under uncertainty, fuzzy optimization. Overview of multi objective optimization, multi criteria decision making, Simulation- optimizations.

Overview of Genetic Algorithm and other evolutionary algorithms Economic analysis, discounting techniques, benefit cost evaluation. River basin modelling, storage-yield relation, reservoir design and operation.

Overview of applications of optimization and simulation techniques in hydrologic and water resources systems – irrigation management, water quality management, groundwater management, water conveyance and distribution systems.

References

1.	K. Deb, Multiobjective Optimization Using Evolutionary Algorithms, John Wiley And Sons, 2001.
2.	K.M. Ravindran, G.V. Reklaitis, Engineering Optimization – Methods And Applications, John
3.	Wiley And Sons, 2006.
4.	S.S. Rao, Engineering Optimization, New Age International (P) Ltd. Publishers, 2000.
5.	Vedula S. And Mujumdar P.P., 'Water Resources Systems: Modelling Techniques And Analysis', Tata-Mcgraw Hill, 2005.
6	Jain S.K. And Singh V.P., 'Water Resources Systems Planning And Management', Elsevier, The Netherlands, 2003.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Apply concepts of systems analysis for planning of water resources systems
CO2	Perform basic economic analysis to evaluate the economic feasibility of water Resources projects
CO3	Formulate and solve deterministic optimization models for design and operation of water resources systems
CO4	Formulate and solve stochastic and fuzzy optimization problems for decision making under uncertainty
CO5	Application of optimisation and simulation techniques in water resources engineering

OPEN ELECTIVE (OE)

CEOE10 REMOTE SENSING AND GIS

Course Code	**:**	CEOE10
Course Title	**:**	**Remote Sensing and GIS**
Type of Course	**:**	OE
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To know about the principles of remote sensing and spectral signatures
CLO2	To know about satellites, types of remote sensing and digital image processing
CLO3	To study about the history and components of GIS
CLO4	To study about data types and operations.
CLO5	To know the applications of remote sensing and GIS for various fields of Civil Engineering

Course Content

Remote Sensing – Principle - Electro-magnetic energy, spectrum - EMR interaction with atmosphere – Atmospheric Windows and its Significance – EMR interaction with Earth Surface Materials – Spectral Signature and Spectral Signature curves for water, soil and Earth Surface.

Satellites - Classification – Satellite Sensors – satellite and sensor parameters -

Resolution – Types of Remote Sensing - Visual Interpretation of Satellite Images – Digital Image processing – Characteristics of different platforms: Landsat, SPOT, IRS series, IKONOS, QUICKBIRD – Radar, LIDAR, SAR, MODIS, AMSRE, Sonar remote sensing systems introduction of GPS- data receiving mode- DTM generation- View shed analysis.

GIS - History of Development - Components of GIS – Hardware, Software and

Organizational Context – Data – Spatial and Non-Spatial – Data Input Sources— DBMS – Data Output - Data models - Raster and Vector data structures – Data compression – Raster vs. vector comparison.

Analysis using Raster and Vector data – Operations – Overlaying - Buffering – Modelling in GIS - Digital Terrain Modelling, Analysis and application – Products of DEMs and their uses – Sources of errors in GIS and their elimination.

Applications of Remote Sensing and GIS – Advanced applications of GIS – Disaster management, Water resource, Landuse – Land cover – Urban planning - Intelligent Transport Systems - Development of Resources Information Systems.

References

1	Burrough P.A. and Rachel A. McDonell, Principles of Geographical Information Systems, Oxford Publication, 2004.
2	C.P. Lo and Albert K. W. Yeung, Concepts and Techniques of Geographical Information Systems, Prentice- Hall India, 2006.

3	Thomas. M. Lillesand and Ralph. W. Kiefer, Remote Sensing and Image Interpretation, John Wiley and Sons, 2003.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Demonstrate the concepts of Electro Magnetic energy, spectrum and spectral signature curves.
CO2	Apply the concepts of satellite and sensor parameters and characteristics of different platforms.
CO3	Apply the concepts of DBMS in GIS.
CO4	Analyze raster and vector data and modeling in GIS.
CO5	Apply GIS in land use, disaster management, ITS and resource information system.

CEOE11 OCEAN ENERGY

Course Code	**:**	CEOE11
Course Title	**:**	**Ocean Energy**
Type of Course	**:**	OE
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	Learn the basics of ocean environment
CLO2	Understand the concept of wave measurement and linear wave theory
CLO3	Learn the ocean tidal current turbulence and wave energy systems
CLO4	Develop model testing techniques for marine current turbines

Course Content

Introduction to the ocean environment - Ocean circulation and stratification - Ocean habitat - Ocean economy - Ocean surface waves - Wave measurement - Linear wave theory - Wave spectrum - Wave energy resource

Ocean tidal currents - Current measurement - Current turbulence o Current energy resource - Site selection and characterization for ocean energy system - Wave energy systems - Types of wave energy converters - Linear wave-structure interactions - Frequency domain analysis - Hydrodynamic coefficients and their computation - Time domain analysis - Phase control Arrays

Model testing techniques - Marine current turbines - Types of marine current turbines

Hydrodynamic models (BEM, Lifting line, IBEM) - Hydrofoil data and analysis

Cavitation and strength - Design criteria - Multiple turbine interaction - Other types of energy systems o- Ocean Thermal Energy Conversion (OTEC) - Energy from salinity gradient

Power take-off systems - Air turbines, Water turbines - High pressure hydraulic systems -

Electrical generation - Energy storage - Mooring and anchoring systems.

Operation and maintenance of ocean energy devices - Offshore operations - Maritime safety issues

References

1	Sorensen, Bent, Renewable Energy, Its Physics, Engineering , environmental impacts, economics, and planning, 3rd Ed. Elisver Academic Press, London, 2004
2	Twidell, John and Weir, Tony, Renewable Energy Resources, Taylor and Francis, 2005

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Understand the basics of ocean energy sources
CO2	Capable of understanding the concepts of measurements of current and tides by using measuring devices
CO3	Understand the different types of marine turbines
CO4	Improves knowledge on water turbines, Electrical operations and marine safety
CO5	Understand OTEC

CEOE12 URBAN AND REGIONAL PLANNING

Course Code	**:**	CEOE12
Course Title	**:**	**Urban and Regional Planning**
Type of Course	**:**	OE
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To develop an awareness about the trends in urbanization
CLO2	To understand the basic principles and concepts of urban planning
CLO3	To learn the laws and regulations related to the planning process existing in the country.
CLO4	To be acquainted with the various stages of the planning process
CLO5	To get introduces to the various agencies and organizations involved in the planning process

Course Content

Definition and classification of urban areas - Trend of urbanization - Planning process - Various stages of the planning process - Surveys in planning.

Plans - Delineation of planning areas -Regional plan, Master plan, Structure plan, detailed development plan and Transportation plan.

Planning principles of Ebenezer Howard (Garden city movement), Patrick Geddes, Dr. C. A. Doxiades, Soria Y Mata (Linear city) and Clarence, A. Perry (The neighbourhood concept).

Plan implementation - Urban Planning agencies and their functions – Financing - Public, private, Non-governmental organizations - Public participation in Planning.

Development control regulations - Town and country planning act - Building bye- laws.

References

1	Hutchinson, B.G., Principles of Urban Transport Systems Planning, Scripta, McGraw-Hill, New York, 1974.
2	Claire, Hand Book of Urban Planning, Van Nostrand Book Company, 1974.
3	Gallian, B. Arthur and Simon Eisner, The Urban Pattern - City Planning and Design, Affiliated Press Pvt. Ltd., New Delhi, 1985.
4	Margaret Roberts, An Introduction to Town Planning Techniques, Hutchinson, London, 1980.
5	Hiraskar, G. K., Fundamentals of Town Planning, Dhanpat Rai Publications, 1992.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Demonstrate the various process involved in urban planning
CO2	Apply the laws and governmental policies related to the planning process
CO3	Implement the classical urban planning principles
CO4	Apply the methods of financing of plans
CO5	Demonstrate the regulations and by-laws

CEOE13 EXPERIMENTAL STRESS ANALYSIS

Course Code	**:**	CEOE13
Course Title	**:**	**Experimental Stress Analysis**
Type of Course	**:**	OE
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To study the working principles of different types of strain gauges
CLO2	To understand the model analysis
CLO3	To know the fundamentals of photo elastic coatings
CLO4	To study the effects of 2-D photo elasticity
CLO5	To study the working principle of load, pressure and displacement transducers

Course Content

Strain gauges – Mechanical, optical, acoustic, electrical inductance and capacitance pneumatic types – description and working principles

Electrical resistance strain gauges, gauge characteristics and types – Equipment for recording static strain – reduction of strain gauge data. Load, pressure and displacement transducers.

Model analysis – direct and indirect models – law of structural similitude – choice of scales – Model materials – limitations of model studies –Buckingham PI theorem – design of direct and indirect models – Beggs deformeter and its applications.

Two dimensional photo – elasticity – optical principles stress optic law – Methods of producing isoclines and isochromatics using polariscopes – Methods of measuring fractional fringe orders – model materials – separation techniques

Fundamental of Photo elastic coatings, Moire fringe and brittle coating techniques – Introduction to stress freezing techniques – Introduction to non-destructive testings

References

1	Daley and Riley, Experimental Stress Analysis, McGraw Hill Book Company, 1987
2	Srinath, L.S. et al., Experimental Stress Analysis, Tata McGraw Hill 1984.
3	Hetenyi, M., Hand Book of Experimental Stress Analysis, John Wiley & Sons. Inc New York. 1980.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Identify the different types of strain gauges
CO2	Carry out model analysis
CO3	Apply the concepts of photo elastic coatings
CO4	Analyze the behavior of 2-D photo elasticity
CO5	Apply the working principles of transducers

CEOE14 SUSTAINABLE INFRASTRUCTURE

Course Code	**:**	CEOE14
Course Title	**:**	**Sustainable Infrastructure**
Type of Course	**:**	OE
Prerequisites	**:**	-
Contact Hours	**:**	36 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To explain the importance of sustainable built environment
CLO2	To emphasis the significance of sustainable development and construction
CLO3	To introduce the techniques and for assessing environmental impact
CLO4	To perform the service life and life cycle assessments
CLO5	To provide exposure to social aspects of sustainability in the construction industry

Course Content

Extent and values of infrastructure (buildings, structures, plants and networks for communication and transport, water and wastewater treatment, production and distribution of energy); relations between infrastructure and sustainable development; regulations and standards; indicators of sustainability; consequences of climate change; vulnerability and safety of infrastructure; materials and technology for construction and management;

Applications for sustainable communities; service life and life cycle assessments (LCA, LCC, MFA, environmental assessment); an international perspective with case studies from around the world.

References

1	Sarte S. B.,'Sustainable Infrastructure: The Guide to Green Engineering and Design, Wiley; 1st edition, 2010.
2	Horne R. E., Grant T., Verghese K., 'Life Cycle Assessment: Principles, Practice and Prospects', CSIRO, 2009.
3	Karli Verghese, Helen Lewis, Leanne Fitzpatrick, 'Packaging for Sustainability', Springer, 2012..
4	FIB bulletin 88, 'Sustainability of precast structures', 2018.
5	Liv Haselbach, *The Engineering Guide to LEED-New Directions (Green Source): Sustainable construction*, McGraw-Hill Professional, 2008.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Understand the values and societal importance of the built environment
CO2	Understand the influence on a sustainable development
CO3	Gain knowledge on how to use environmental impact assessments as a tool for design
CO4	Construction and management of a sustainable built environment
CO5	Comprehend the aspects of social sustainability in the construction industry

CEOE15 DISASTER MODELLING AND MANAGEMENT

Course Code	**:**	CEOE15
Course Title	**:**	**Disaster Modelling and Management**
Type of Course	**:**	OE
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To know the types of Disasters and its triggering factures.
CLO2	Understand the stages of disaster in hydrological disaster and kinds of data are required to support emergency management work during the disasters.
CLO3	Develop and understand the causes, effects, impacts and analysis of hydrological, geological and coastal hazards.
CLO4	Assess the potential of new, evolving technologies to meet vulnerability mapping, modelling and emergency management needs for geological hazards, hydrological and coastal hazards

Course Content

Disasters: Definition- Hazard Risk, Mitigation, Natural and human induced disasters- types of hazards, disasters and catastrophes – Disaster Management.

Hydrological Hazards: Flooding – PMP – PMF – Inundation mapping -flood prone area analysis and management. Dam breach analysis - Drought- types of drought - Factors influencing drought - delimiting drought prone areas - drought index, SPI and Palmer.

Geological Hazards: Earthquakes; location, faults, causes, types, associated hazards and impacts, Richter scale and Modified Mercalli scale. Mass movements: Definition of landslide - types – causes - slope stability analysis.

Coastal Hazards – storm surge - Tsunami and floods – cyclone – coastal vulnerability – shore line erosion – shore defence structures.

Mitigation and Management: Hazard, Risk and Vulnerability mapping and modelling using GIS. Case studies for earth quake zonation. Risk Assessment - Preparedness- GIS case studies for earthquake, landslide–risk assessment–GIS case studies for earthquake, landslide and cyclones. Emergency Management Systems (EMS) in the Disaster Management Cycle.

References

1.	National Disaster Management Division (2004) Disaster Management in India - A Status Report, Ministry of Home Affairs, Government of India, New Delhi.
2.	UNDRO (1995) Guidelines for Hazard Evaluation Procedures,United Nations Disasters Relief Organization, Vienna.
3.	Nagarajan, R., (2004) Landslide Disaster Assessment and Monitoring, Anmol Publications, New Delhi.
4.	Ramkumar, Mu, (2009) Geological Hazards: Causes, Consequences and Methods of Containment, New India Publishing Agency, New Delhi.
5.	Arnold M et.al Ed. (2006) Natural Disaster Hotspots:Case Studies. The World Bank Hazard Management Unit Washington, D.C.204p

Course Outcomes (CO)

At the end of the course student will be able

CO1	Understand different types of disaster and its triggering features
CO2	Understand and analyse hydrological disaster
CO3	Understand and develop models for geological disaster
CO4	Able to understand the coastal hazard and shore defence structures
CO5	Capable to preparing vulnerability mapping and risk assessment and developing Emergency Management System

CEOE16 STANDARDIZATION AND CONFORMITY ASSESSMENT

Course Code	**:**	CEOE16
Course Title	**:**	**Standardization and Conformity Assessment**
Type of Course	**:**	OE
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	Understand the historical evolution of standards and standardization from ancient times to modern times.
CLO2	Comprehend and identify the Standards and Standardization at National, International and Regional level.
CLO3	Understand the BIS Act and the structure of BIS, including its committees and standard formulation departments.
CLO4	Gain an understanding on BIS certification and the conformity assessment scheme for products, Compulsory Registration Scheme (CRS) and different types of BIS approvals.
CLO5	Grasp the fundamentals of conformity assessment, including its definition, objectives, and classification.

Course Content

Standardization: Standards - History of standards and standardization - standardization in Ancient world - standardization in Ancient India - standardization according to Arthshastra - World war II and rise of standardization - standardization in modern world - standardization activity worldwide – standardization activity in India – WTO/TBT - role of regularity bodies in standardization – technical regulations

Standard formulations: System of standardization – Indian – International – Regional – Types of standards – Procedure of standards development – standards and innovations – standardization as a base line for implementing innovation – strategic standards management – life cycle of standards – legal impact at policy issues associated with standardization

Bureau of Indian Standard (BIS): Objects – Functions of BIS – BIS Act - Main Activities – Members of BIS – BIS Committees – Standard Procedure – Functions of the Standards Formulation Departments - purpose of standardization, marking and certification of articles and process – importance of standards to industry, policy makers, trade, sustainability and innovation.

BIS Product Certification in India: Introduction to BIS Certification – Conformity Assessment Scheme for Products - Compulsory Registration Scheme (CRS) - Types of BIS Approvals - BIS Services and Supports - Regulatory Updates – International Cooperation - Global Certification an Overview.

Brief Introduction to IS Codes in Circuit and Non-Circuit Branches of Engineering.

Conformity Assessment: Fundamentals of conformity assessment -Definition and objectives; classification of assessment- merits and limitations; certification-importance and the process; accreditation-role, accreditation bodies (National & International), Process; types of certificates; role of accreditation; Practical applications and case studies.

References

1.	ISO Standards Handbook, International Organization for Standardization
2.	Alan Bryden and Dr. Samad El-Hout, Conformity Assessment: Fundamentals and Practice.

3.	Russell, J. P., The ISO 9001:2015 Handbook.
4.	Jacobson Kai, The Role of Standards in Today's society and in the future.
5.	John. G. Keogh, Hakan Anderson, International Conformity Assessment: Current Practices and Future Directions.
6.	BIS standards catalogue by Bureau of Indian Standards.
7.	ISO/IEC 17000: Conformity Assessment – Vocabulary and General Principles.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Understand the evolution and global activities of standardization, including the role of regulatory bodies.
CO2	Learn the system and procedures for developing standards, including their impact on innovation and policy.
CO3	Understand the functions, procedures, and importance of BIS in Indian standardization.
CO4	Gain knowledge of BIS certification schemes and regulatory updates.
CO5	Understand the fundamentals of conformity assessment and the role of IS codes in engineering.

CEOE17 COMPUTATIONAL FLUID DYNAMICS

Course Code	**:**	CEHO17
Course Title	**:**	**Computational Fluid Dynamics**
Type of Course	**:**	OE
Corequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the basic concepts in flow governing equations and need for turbulence modelling
CLO2	To provide fundamental knowledge on finite difference and volume methods.
CLO3	To describe the solution methodologies for discretized equations.
CLO4	To describe concepts in P-V coupling algorithms.
CLO5	To develop models using structured and unstructured grids.

Course Content

Derivation of flow governing equations; turbulence modeling; modeling approaches for multiphase flow; initial and boundary conditions; wellposedness.

Discretization of the governing equations using finite difference/volume/element methods; concepts of consistency, stability and convergence; template for the discretization of a generic unsteady transport equation.

Solution of discretized equations; direct methods; classical iterative methods; advanced

methods for structured matrices; conjugate gradient techniques; multigrid methods.

Solution of coupled equations: methods for compressible flows; evaluation of pressure in incompressible flows; pressure-velocity coupling algorithms.

Structured and unstructured grids; structured grid generation; unstructured grid generation. Benchmarking; calibration.

References

1.	John Anderson, Computational Fluid Dynamics, McGraw-Hill Education, 1999
2.	Pieter Wesseling, Principles of Computational Fluid Dynamics, Springer series, 2009
3.	Anil W. Date, Introduction to Computational Fluid Dynamics, Cambridge, 2005
4.	Charles Hisch, Numerical computation of internal and external flows, Elsevier, 2007

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Derive and analyze flow governing equations for various fluid dynamics.
CO2	Implement and evaluate turbulence and multiphase flow modeling techniques.
CO3	Discretize governing equations using finite volume methods for accurate solutions.
CO4	Solve discretized equations with direct, iterative, and advanced numerical methods.
CO5	Design structured and unstructured grids; perform benchmarking and calibration.

CEOE18 HYDROINFORMATICS

Course Code	**:**	CEOE18
Course Title	**:**	**Hydroinformatics**
Type of Course	**:**	OE
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand Satellite Products: Learn about sensor types, characteristics, and data analysis methods.
CLO2	To develop skills in modelling, machine learning, and programming.
CLO3	To use linear models, GLMs, and neural networks for data analysis.
CLO4	To apply clustering methods and multivariate analysis techniques.
CLO5	To use hydroinformatics for climate change impact and flood analysis.

Course Content

Satellite Products-Types and classification of sensors, imaging modes, characteristics of optical sensors, sensor resolution-spectral, radiometric and temporal, characteristics of detectors- Geospatial analysis using Raster and Vector data – File format, Data conversion between Raster and vector Projection and transformation - Reclassification - Neighbourhood and Regional Operations – Map Algebra – Vector Data Analysis - Proximity analysis - Attribute data Analysis- concepts of SQL. Tools for map Analysis: Weighted

overlay, Boolean logic models – Index overlay models – Fuzzy logic method

Introduction to hydroinformatics - data-driven modeling for water systems, Model classification, Models overview, Modeling accuracy, Introduction to machine learning and artificial intelligence, Introduction to Matlab and Python Programming

Linear Models, Generalized linear models (GLMs) – Logistic Regression, Poisson Regression, Gamma and Exponential GLMs, k-Nearest Neighbors (kNN), Polynomial regression and Generalized additive models, Kernel-based methods, Decision trees - Classification and Regression Trees (CART) - Bagging, Boosting and Random Forests, Support Vector Machines (SVM), Artificial Neural Networks (ANN), Resampling methods - Bootstrap, Regularization and Machine Learning System Design.

Clustering: i) Hard (k-means) clustering and ii) Fuzzy clustering (fuzzy c-means) with introduction to fuzzy logic, Multivariate analysis - dimension reduction, singular value decomposition (SVD) analysis, principal component analysis (PCA), canonical correlation analysis (CCA).

Hydroinformatics for Climate Change Impact Assessment and Regional Flood Frequency Analysis; Example of a Hydrologic Information System_case studies

References

1	Lillesand, T. M. and R.W. Kiefer, remote Sensing and Image Interpretation, Fourth Edition, John Wiley
2	Von Storch and Zwiers, 1999, Statistical Analysis in Climate Research, Cambridge Univ. Press, U.K
3	Myers, R. H., Montgomery, D. C., Vining, G. G., & Robinson, T. J. (2012). Generalized linear models: with applications in engineering and the sciences (Vol. 791). John Wiley & Sons
4	Abbott, 1991, Hydroinformatics- Information Technology and the Aquatic Environment, Avebury Technical, Aldershot, U.K
5	James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). An introduction to statistical learning (Vol. 112). New York: Springer. (Alternatively, Hastie et al., 2008, The Elements of Statistical Learning - for advanced)

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Describe sensor types, resolutions, and perform geospatial analysis using raster and vector data.
CO2	Implement data-driven modelling and machine learning techniques in Matlab and Python.
CO3	Use statistical and machine learning models to solve practical hydroinformatics problems.
CO4	Apply clustering and multivariate analysis techniques to complex datasets.
CO5	Conduct impact assessments for climate change and flood frequency using hydroinformatics methods.

CEOE19 RELIABILITY METHODS

Course Code	**:**	CEOE19
Course Title	**:**	**Reliability methods in Civil Engineering**
Type of Course	**:**	OE
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	Grasp the fundamentals of basic statistics and probability theory relevant to civil engineering.
CLO2	Perform probabilistic analysis of various loads, including gravity and wind loads
CLO3	Develop skills in modeling structural systems for reliability analysis
CLO4	Gain proficiency in applying FOSM and Monte Carlo methods
CLO5	Analyze and solve real-world reliability issues in civil engineering, demonstrating the application of statistical and probabilistic methods to ensure structural safety and performance

Course Content

Basic Statistics: Introduction, data reduction, Concepts of structural safety. Probability theory: Introduction, random events, random variables, functions of random variables, moments and expectation, common probability distributions.

Resistance distributions and parameters: Introduction, Statistics of properties of concrete, steel and other building materials, statistics of dimensional variations, characterization of variables, allowable stresses based on specified reliability. Probabilistic analysis of loads: gravity loads, wind loads

Basic structural reliability: Introduction, computation of structural reliability. Level 2 Reliability methods: Introduction, basic variables and failure surface, first order second moment methods (FOSM), Monte Carlo method.

Reliability of Structural system: Introduction, system reliability, modelling of structural systems, bounds of system reliability, reliability analysis of frames

References

1	R. Ranganathan., Reliability Analysis and Design of Structures, Tata McGraw Hill, 1990.
2	Ang, A. H. S & Tang, W. H., Probability Concepts in Engineering Planning and Design, Vol. I Basic Principles, John Wiley & Sons, 1975.
3	Ang, A. H. S & Tang, W. H., Probability Concepts in Engineering Planning and Design, Vol. II Decision, Risks and Reliability, John Wiley & Sons, 1984.

4	Jack R. Benjamin & C. Allin Cornell., Probability, Statistics and Decision for Engineers, McGraw-Hill, 2014
5	R. E. Melchers. Structural Reliability - Analysis and prediction, Ellis Horwood Ltd, 1987.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Demonstrate the ability to apply basic statistical methods and probability theory to analyze structural safety and performance.
CO2	Analyze and interpret resistance distributions and statistical parameters for materials like concrete and steel.
CO3	Compute the reliability of structural components using various methods
CO4	Evaluate reliability indices for simple structural problems viz., beams, trusses.
CO5	Apply reliability methods to solve practical civil engineering problems, ensuring the safety and performance of structures.

CEOE20 UNCERTAINTY MODELING, ANALYSIS AND QUANTIFICATION

Course Code	**:**	CEOE20
Course Title	**:**	**Uncertainty Modeling, Analysis and Quantification**
Type of Course	**:**	OE
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	Understanding the basics and sources of uncertainty, and differentiate between deterministic and nondeterministic perspectives
CLO2	Utilize fundamental concepts of probability and statistics
CLO3	Employ various uncertainty modeling methods and sampling techniques
CLO4	Develop and apply computational tools for uncertainty propagation
CLO5	Develop and apply methods for uncertainty quantification

Course Content

Propagation of uncertainty. Deterministic vs nondeterministic perspectives. Sources of uncertainty. Epistemic vs. aleatoric uncertainty. Data driven vs. physics driven uncertainty modelling. Different approaches such as probabilistic, interval, fuzzy.

Introductory probability and statistics, Uncertain Variable – Variables, Distribution, Operational Laws, Expected value, Variance, Moment, Entropy, Distance, Conditional Uncertainty Distribution, Uncertain Sequence, Uncertain Vector, Point estimation, hypothesis testing, time series.

Uncertainty Modeling methods and Sampling Techniques – High dimensional model representation, Response Surface methods, Kriging model, Model reduction, Various Sampling and optimization techniques and solutions.

Modelling: connecting data to the probabilistic models. Discretization of random fields. Karhunen-Loève expansion of random fields. Tools for uncertainty propagation. Computational aspects of uncertainty propagation. Uncertainty Quantification – Sensitivity analysis..

References

1	Haym Benaroya and Seon Mi Han, Probability models in engineering and science, Taylor and Francis, 2005
2	Ghanem, Roger, David Higdon, and Houman Owhadi, eds. Handbook of uncertainty quantification. Vol. 6. New York: Springer, 2017.
3	De Cursi, Eduardo Souza, and Rubens Sampaio. Uncertainty quantification and stochastic modelling with MATLAB. Elsevier, 2015.
4	Smith, Ralph C. Uncertainty quantification: theory, implementation, and applications. Society for Industrial and Applied Mathematics, 2013.
5	Sullivan, Timothy John, Introduction to Uncertainty Quantification, Springer, 2015

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Represent mathematically the uncertainty in the parameters of physical models.
CO2	Propagate parametric uncertainty through physical models to quantify the induced uncertainty on quantities of interest.
CO3	Develop and implement models for representing random fields and their uncertainties.
CO4	Combine multiple sources of information to enhance the predictive capabilities of models
CO5	Apply methods to quantify the uncertainties in a system

CEOE21 APPLICATION OF REMOTE SENSING AND GIS IN AGRICULTURE AND FORESTRY

Course Code	**:**	CEOE21
Course Title	**:**	**Application of Remote Sensing and GIS in Agriculture and Forestry**
Type of Course	**:**	OE
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To Understand principles, techniques, and applications of remote sensing in agriculture, focusing on spectral characteristics, vegetation indices, and crop monitoring.
CLO2	To Learn microwave remote sensing for agricultural application and different satellite missions on RADAR
CLO3	To understand hyperspectral sensors agriculture in particular with crop monitoring
CLO4	To explore remote sensing in agro-meteorology, including its applications in crop damage assessment, drought management, and agricultural insurance.
CLO5	To learn remote sensing techniques for forest inventory, biomass assessment, and forest degradation mapping, with a focus on sustainable forest management

Course Content

Remote sensing in agriculture – an overview- leaf optical properties -Spectral characteristics of crops- factors affecting spectral signatures of crops- vegetation indices - Plant Biophysical and Biochemical Properties- Temporal characteristics of vegetation - Principles of crop identification and crop acreage estimation-Crop yield modelling using remote sensing

Principles, basic concepts of microwave remote sensing-SLAR and SAR-Geometric-characteristics, Spatial resolution and Interpretation of data- RADAR Data Characteristics - Principles of Soil Moisture Retrieval - Vegetation Structure Analysis - Soil Texture and Structure Analysis -Spaceborne Radar System: SEASAT, ERS, RADARSAT, RISAT, Sentinel 1, NISAR Applications of RADAR in agriculture- Machine Learning in RADAR Data Analysis

Fundamentals of Hyperspectral Imaging- Principles, sensor technology, and data characteristics- Pre-processing of Hyperspectral Data- Spectral reflectance properties of soil, water, and vegetation-hyper spectral sensing for crop inventory –crop health monitoring and condition assessment– Nutrient Deficiency- Case studies

Agro-meteorology – its importance and application of RS in agro-meteorology -Damage by pests and diseases-crop loss assessment by floods -flood hazard zone mapping-remote sensing capabilities and contributions for drought management- land degradation due to water logging and salinity -reflectance properties of stressed crops- identification of crop stress –Agricultural insurance in India –CCIS, ECIS, FIIS and NAIS

Introduction -inventory of forests-forest type and density mapping- bio mass assessment-timber volume estimation-factors for forest degradation-mapping degraded forests deforestation and afforestation-forest fire mapping and damage assessment–species mapping - sustainable development of forests.

References

1	Applications of Remote Sensing in Agriculture (2013) United Kingdom Elseiver Science
2	Remote Sensing of Agricultural crops & Vegetation by Mutlu Ozdogan, Yang Yang, Excelic press, 2020

3	Remote Sensing for Sustainable Forest Management, Steve E. Franklin, CRC Press 2001
4	Srinivas,M.G.,Remote Sensing Applications, Narosa Publishing House,NewDelhi,2001.
5	Andrew Rencz, Manual of Remote Sensing. Vol.3. Edn.3. Remote Sensing for the Earth Sciences, American Society for photogrammetry and Remote Sensing, John Wiley& Sons, New York, 1999

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Analyze remote sensing data to assess crop health, estimate crop yield.
CO2	Process and interpret radar data for various agricultural applications, including soil moisture retrieval, vegetation structure analysis.
CO3	Getting an idea about Hyperspectral remote sensing and its application on crop monitoring
CO4	Utilize remote sensing data for assessing crop losses, managing droughts, and applying agro-meteorological principles
CO5	Apply the geospatial techniques for monitoring deforestation and forest management practices,

ESSENTIAL LABORATORY REQUIREMENT (ELR)

CELR10 BUILDING PLANNING AND DRAWING

Course Code	**:**	CELR10
Course Title	**:**	**Building Planning and Drawing**
Type of Course	**:**	ELR
Corequisites	**:**	-
Contact Hours	**:**	
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the principles of planning site selection orientation and and bylaws.
CLO2	To develop the ability to create and interpret architectural drawings such as plan, elevation and section of a building.
CLO3	To acquire knowledge about different types of buildings, including residential, commercial, and industrial structures, and the specific planning requirements for each
CLO4	To learn the process of integrating functional, aesthetic, and environmental considerations into building designs,
CLO5	To cultivate skills in the preparation of working drawings and components of building such as doors, windows, etc.

Course Content

Classification of buildings -Principles of planning -Dimensions of buildings -Building bye-laws for floor area ratio, open spaces -Orientation of buildings -Lighting and Ventilation-Planning and preparing sketches and working drawings of Residential buildings (Flat and sloping roof), Schools, Hostels, Hospitals, Single-storey factory buildings with trusses. Detailed working drawings of the component parts -Doors and Windows -Roof Trusses -Staircases-Toilets

References

1.	Shah M.G. Kalec. M. & Patki SY Building Drawing, Tata Mcgraw Hill, New Delhi, 2000
2.	Kumara swamy N & Kumereswara Rao, Building Planning and Drawing, Charotrar Publishing House Pvt,Ltd. 2015
3.	Building Planning and Drawing" by M. Chakraborti, Charotrar Publishing House Pvt,Ltd. 2015.
4.	B.C. Punmia, Ashok Kumar Jain, and Arun Kumar Jain, Building Construction, Laxmi Publication 2012.
5.	B. P. Verma ,Civil Engineering Drawing and House Planning, Khanna Publishers 2015.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	To apply fundamental principles of building planning to design functional and aesthetically pleasing structures that comply with relevant building bylaws and standards.
CO2	Proficient in creating and interpreting architectural drawings, including floor plans,

	elevations, sections, and construction details, using both manual and CAD techniques.
CO3	Ability to plan and design various types of buildings, considering specific requirements for residential, commercial, and industrial structures.
CO4	Integrating functional, aesthetic, and environmental considerations into building designs, promoting efficiency and sustainability in construction projects.
CO5	Develop skills necessary to prepare comprehensive working drawings and detailed drawings for different building components

CELR11 SURVEY LABORATORY

Course Code	**:**	CELR11
Course Title	**:**	**Survey Laboratory**
Type of Course	**:**	ELR
Corequisites	**:**	-
Contact Hours	**:**	
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	Introduction to Chain Surveying and Compass Surveying.
CLO2	Plane Table Surveying – Radiation, intersection, Traverse, Resection Leveling.
CLO3	Tacheometry and Theodolite survey
CLO4	Trigonometric levelling to determine heights/elevations.
CLO5	Advanced Equipments like Total Station, Digital Level, GPS, Drone

Course Content

1. Chain and Compass surveying
2. Plane table surveying
3. Leveling: Fly leveling and contouring
4. Theodolite surveying – Radiation, Intersection Method
5. Single and two plane observation of trigonometric leveling
6. Determination of Tacheometric Constants, Estimation of area using Tangential Tacheometry
7. Total station, Digital Level, GPS, Drone

References

1.	Duggal, S.K. Surveying Vol. I and II, Tata McGraw Hill, 2019.
2.	Punmia, B.C. Surveying Vol.I and II, Laxmi Publications, 2016 (Vol I), 2023 (Vol II).
3.	Punmia, B.C. Higher Surveying Vol III, Laxmi Publications, 2022.
4.	Arora, K. R. Surveying Vol. I and II, Standard Book House, 2019.
5.	Satheesh Gopi. Advanced Surveying, Pearson Education, 2017.
6	Satheesh Gopi. The Global Positioning System, Tata McGraw, 2017.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Use conventional surveying tools such as chain/tape, compass, plane table, level in the field of civil engineering applications such as structural plotting and highway profiling.
CO2	Apply the procedures involved in field work and to work as a surveying team.
CO3	Plan a survey appropriately with the skill to understand the surroundings.
CO4	Take accurate measurements, field booking, plotting and adjustment of errors can be understood.
CO5	Understand the use of Conventional Surveying and Advanced Surveying techniques in practical applications of civil engineering

CELR12 FLUID MECHANICS LABORATORY

Course Code	**:**	CELR12
Course Title	**:**	**Fluid Mechanics Laboratory**
Type of Course	**:**	ELR
Corequisites	**:**	-
Contact Hours	**:**	
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the flow measurement in a pipe flow
CLO2	To determine the energy loss in pipe flow
CLO3	To study the characteristics of turbines
CLO4	To study the characteristics of pumps
CLO5	To measure the discharge in a open channel flow

Course Content

1. Determination of pipe friction
2. Calibration of flow meters - Venturimeter and Orifice meter
3. Determination of discharge coefficients for notches 4. Determination of minor losses
5. Pressure gauge calibration.
6. Centrifugal pump
7. Submersible pump
8. Reciprocating pump
9. Jet pump
10. Gear pump
11. Screw pump
12. Francis Turbine

References

1.	R. K. Bansal, ‘A Textbook of Fluid Mechanics and Hydraulic Machines’, 2010, Lakshmi Publications
2.	P. Balachandran, ‘Experiments in Fluid Mechanics’, 2011, PHI Learning
3.	K. Subramanya: " Fluid Mechanics & Hydraulic Machines " (2012), Tata McGraw-Hill Education
4.	D. S. Kumar: "Fluid Mechanics and Fluid Power Engineering" (2014), S. K. Kataria &

	Sons
5.	C. S. P. Ojha, R. Berndtsson, and P. N. Chandramouli, "Fluid Mechanics and Machinery" (2010), Oxford University Press
6.	Dr. P.N. MODI & S.M. SETH, “Hydraulics and Fluid Mechanics Including Hydraulics Machines”, 2019, Amit Publisher and Distributors

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Measure discharge in pipes
CO2	Determine the energy loss in conduits
CO3	Demonstrate the characteristics curves of pumps
CO4	Demonstrate the characteristics curves of turbines
CO5	Carry out discharge measurements in open channel

CELR13 STRENGTH OF MATERIALS AND CONCRETE LABORATORY

Course Code	**:**	CELR13
Course Title	**:**	**Strength of Materials and Concrete Laboratory**
Type of Course	**:**	ELR
Corequisites	**:**	-
Contact Hours	**:**	
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To find the Young Modulus, torsional strength, hardness and tensile strength of given specimens
CLO2	To find impact value and crushing value of coarse aggregates
CLO3	To find the compressive strength of concrete cubes and bricks
CLO4	To find stiffness of open coiled and closed coiled springs
CLO5	To find the physical properties of given coarse aggregate, fine aggregate and cement samples

Course Content

1. Tests on springs - modulus of rigidity of the spring.
2. Stress-strain characteristics of HYSD bars.
3. Young’s modulus of the given material (steel or wood) by conducting bending test on simply supported beam.
4. Brinel’s, Vickers, Rockwell hardness tester.
5. Normal consistency, fineness, Initial setting and final setting time of cement.
6. Specific gravity, soundness and Compressive strength of Cement.
7. Specific gravity of fine and coarse aggregates.
8. Fineness modulus of fine aggregate and coarse aggregate.
9. Impact strength, crushing strength and water absorption test on coarse aggregate.
10. Concrete mix design (IS method).
11. Tests on Concrete.
12. Compressive and spilt-tensile strength of concrete.

13. Modulus of Elasticity/stress-strain curve in concrete.
14. Permeability test and NDT Tests (only Demonstration)

References

1.	IS 516, Methods of Tests for Strength of Concrete, Bureau of Indian Standards, New Delhi, 1959
2.	IS 2386 (Parts 1 to 12), Methods of Tests for Aggregates for Concrete, Bureau of Indian Standards, New Delhi, 1963
3.	IS 10262, Guidelines for Concrete Mix Design Proportioning, Bureau of Indian Standards, New Delhi, 2009
4.	Rajput, R K, Strength of Materials (Mechanics of Solids), S Chand Publisher, 2015
5.	IS 1608, Mechanical Testing of Metals - Tensile Testing, Bureau of Indian Standards, New Delhi, 2005

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Evaluate Young Modulus, torsional strength, hardness and tensile strength of given specimens.
CO2	Determine the strength of coarse aggregates.
CO3	Design concrete mixes and find the compressive strength of concrete cubes and bricks.
CO4	Find stiffness of open coiled and closed coiled springs.
CO5	Determine the physical properties of given coarse aggregates, fine aggregates and cement samples.

CELR14 GEOTECHNICAL ENGINEERING LABORATORY

Course Code	**:**	CELR14
Course Title	**:**	**Geotechnical Engineering Laboratory**
Type of Course	**:**	ELR
Corequisites	**:**	-
Contact Hours	**:**	
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	Perform grain size analysis and other index tests to determine the coarse and fine soil properties.
CLO2	Measure the consistency limits of fine-grained soils using relevant laboratory techniques.
CLO3	Conduct and analyze results from shear strength tests, including direct shear, triaxial shear, vane shear, and unconfined compressive tests.
CLO4	Estimate key engineering properties of soils, such as density, permeability, and compaction characteristics using relevant tests.
CLO5	Integrate and interpret the data obtained from various soil tests to assess soil suitability for construction and design purposes.

Course Content

1. Grain Size analysis.
2. Consistency limits
3. Specific gravity.
4. Permeability tests
6. Unconfined compression test.
7. Direct shear test.
8. Core cutter and sand replacement
9. Compaction test
10. California bearing ratio test
6. 10.Vane shear test.
7. 11.Tri-axial test
8. 12.Consolidation test

References

1.	Bowles, J.E. (1979). Physical and Geotechnical Properties of Soils, McGraw Hill Publishers.
2.	BS 1377 (Part 1 to 8). Methods of Test for Soils for Civil Engineering Purposes, British Standard Institute.
3.	Head, K.H. (1982). Manual of Soil Laboratory Testing, Vol. 1,2, 3 Soil classification and compaction tests, Whittles Publishing, Scotland, UK.
4.	IS 2720 (Various parts). Methods of Test for Soils, Bureau Of Indian Standards.
5.	Lambe (1951). Soil Testing in Engineering, Wiley & Sons.
6.	Mandal, J.N. and Divshikar, D.G. (1994). Soil Testing in Civil Engineering, Oxford & IBH Publishing Company Pvt. Ltd., New Delhi

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Students will classify soil types accurately based on index properties and assess their suitability for construction applications.
CO2	Students will measure and interpret the consistency limits and compaction characteristics of soils effectively.
CO3	Students will perform and analyze tests to estimate soil shear strength parameters required for engineering design.
CO4	Students will estimate and evaluate the engineering properties of soils, such as density, permeability, and California Bearing Ratio (CBR), using appropriate tests.
CO5	Students will integrate and interpret the results from various soil tests to provide comprehensive evaluations of soil behavior and suitability for construction

CELR15 ENVIRONMENTAL ENGINEERING LABORATORY

Course Code	**:**	CELR15
Course Title	**:**	**Environmental Engineering Laboratory**
Type of Course	**:**	ELR
Corequisites	**:**	-
Contact Hours	**:**	

Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn the characteristics of water
CLO2	To familiarize the environmental significance of water quality parameters
CLO3	To know the organic strength of wastewater
CLO4	To introduce bacteriological tests for detecting microbial content in water
CLO5	To study the methods for determining optimum coagulant dosage for water treatment

Course Content

Physical and Chemical characteristics of water: pH -Turbidity - Hardness – Alkalinity – Chlorides – Sulphates – Iron - Residual chlorine- Total solids- Dissolved solids – suspended solids-Organic and inorganic solids –DO – BOD – COD; Bacteriological tests: - Standard plate count Test-Microscopic tests; Jar Test study.

References

1.	Guideline manual: Water and Wastewater Analysis, Central Pollution control Board, Ministry of Environment & Forest, New Delhi, India
2.	Experimental methods in wastewater Treatment, IWA Publishing

Course Outcomes (CO)

At the end of the course student will be able to

CO1	analyze physical characteristics of water and wastewater
CO2	quantify the inorganic solids in water
CO3	estimate organic fraction in wastewater
CO4	assess the microbial contamination in water
CO5	recommend the degree of treatment required for the water and wastewater

CELR16 TRANSPORTATION ENGINEERING LABORATORY

Course Code	**:**	CELR16
Course Title	**:**	**Transportation Engineering Laboratory**
Type of Course	**:**	ELR
Corequisites	**:**	-
Contact Hours	**:**	
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To organize traffic surveys
CLO2	To collect wide variety of traffic data
CLO3	To conduct standard tests on aggregate and bitumen
CLO4	To do mix design for GSB
CLO5	To carry out design of bituminous mixes

Course Content

Traffic Surveys - Volume count , Intersection turning movements , Speed study, Speed and delay study

1. Moving observer survey
2. Parking study

Tests on aggregate

3. Shape Test - Flakiness and Elongation Index
4. Los Angeles Abrasion Test

Tests on bitumen

5. Specific Gravity
6. Penetration Grade
7. Softening Point
8. Ductility Value
9. Flash and Fire Point
10. Viscosity Value

Mix design

11. Granular Sub-base
12. Bituminous Layer

References

1.	Khanna, S. K., Justo, C. E. G. and Veeraragavan A., Highway Engineering, Nem Chand and Bros, Roorkee, 2014.
2.	Kadiyali, L. R., and Lal, N. B., Principles and Practices of Highway Engineering, Khanna Publishers, 2008.
3.	Kadyali, L.R., Traffic Engineering and Transport Planning, Khanna Publication, Delhi, 2011.
4.	Relevant IRC Codes of Practices
5.	Ministry of Road Transport and Highways, Specifications for Road and Bridge Works, Indian Roads Congress 2004

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Conduct various traffic surveys
CO2	Collect traffic data
CO3	Perform laboratory tests on aggregate and bitumen
CO4	Conduct mix design for GSB
CO5	Carry out mix design for Bituminous mixes

CELR17 COMPUTATIONAL LABORATORY

Course Code	**:**	CELR17
Course Title	**:**	**Computational Laboratory**
Type of Course	**:**	ELR
Corequisites	**:**	-
Contact Hours	**:**	

Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn the software developing skills for structural design.
CLO2	To understand the computing techniques in the field of transportation.
CLO3	To gain knowledge in problem solving in water resources.
CLO4	To learn the software skills in structural engineering, transportation engineering, water resources engineering, geotechnical engineering and GIS and Remote Sensing, construction management and project scheduling

Course Content

Usage of commercially established software for

1. Design of the structural elements in concrete and steel.
2. Transportation Engineering problems: Highway geometrics, pavement design.
3. Geotechnical Engineering problems: Earth pressure, Foundation settlement and stress analysis, Consolidation.
4. Problems in Environmental and Water resources engineering: Treatment systems, Pipe networks analysis, Synthetic Unit hydrograph derivation, Flood routing, Water balance model.
5. Problems in BIM, construction management and scheduling for PERT and CPM
6. GIS and Remote sensing applications

References

1.	Rajasekaran S, Computational Structural Mechanics, Prentice Hall of India, New Delhi, 2001.
2.	Manickaselvam V.K., Elements of Matrix and Stability Analysis of Structures, Khanna Publishers, New Delhi, 1998.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	To learn the software developing skills for structural design.
CO2	To understand the computing techniques in the field of transportation
CO3	To gain knowledge in problem solving in water resources.
CO4	To learn the software skills in geotechnical engineering, GIS and Remote Sensing.
CO5	To understand the computing techniques in construction management and project scheduling.

MINORS (MI)

CEMI10 CONSTRUCTION TECHNOLOGY

Course Code	**:**	CEMI10
Course Title	**:**	**Construction Technology**
Type of Course	**:**	MI
Corequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To know the properties and applications of different construction materials
CLO2	To understand the production, processing and testing of concrete
CLO3	To learn the construction principles, formwork and other construction methods
CLO4	To study the types of building finishes and building services
CLO5	To learn the different repair techniques in construction

Course Content

Building materials: Classification and requirements of good stone and brick, Brick manufacturing, Harmful ingredients, testing, Constituent of a good brick earth, Lime, manufacturing, Field-testing, Artificial hydraulic lime; Timber: classification, structure, seasoning, defects; Paints: Constituents, types, characteristics of varnishes.

Concrete technology: High grade cements, Advances in manufacture of cement, Concrete Mix Design; Process of manufacture of concrete, Batching, mixing, transporting, placing, compaction, curing, finishing; Testing of fresh and hardened concrete; Non-destructive testing.

Principles of building construction: Bonding, Reinforced brick work, Stone masonry, Hollow block masonry, Composite masonry, Cavity walls, Flooring, Formwork, Shoring and Scaffolding, Slip and moving forms, Roofs and roof coverings, Under pinning, Submerge structures.

Building items: Plastering & pointing, Painting, Distempering and white washing; Damp proof course (DPC), Anti-termite measures and treatments; Construction joints; Plumbing and electrification, various types of fittings and laying procedure.

Construction damages & repair techniques: Causes of damage and deterioration in masonry and concrete structures, Symptoms & Diagnosis, Types of repair and rehabilitation techniques; Case studies.

References

1.	Duggal, S.K., Building Materials, New Age International, 2009.
2.	Rangwala, S.C., Engineering Materials, Charotar, 2015.
3.	Arora, S.P. and Bindra, S.P., Building Construction, Dhanpat Rai and Sons, 1997
4.	Punmia, B.C., Building Construction, Laxmi Publications (P) Ltd., 1993
5.	Peurifoy, R.L., Form work for Concrete Structures, McGraw Hill Book Co., 1999.

6.	Shetty, M.S., Concrete Technology, S.Chand and Company., 2011
7.	Neville A.M., Properties of Concrete, Fourth edition, Pearson Education Ltd. 2004.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Distinguish the different construction materials and select appropriate materials for construction
CO2	Design suitable concrete mixes and test the concrete
CO3	Execute construction jobs with the knowledge of the different construction techniques
CO4	Comprehend the different types of building finishes and gain the ability to supervise the execution of different building services
CO5	Identify the building defects and apply suitable repair techniques to rectify them

CEMI11 SURVEYING PRACTICES

Course Code	**:**	CEMI11
Course Title	**:**	**Surveying Practices**
Type of Course	**:**	MI
Corequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the importance of surveying in the field of civil engineering
CLO2	To get introduced to different plane and geodetic surveying applications such as chain, compass, plane table, leveling, triangulation, trigonometric leveling etc
CLO3	To understand the significance of each method in civil engineering and master the skill to carry out the proper surveying method in the field.
CLO4	To design numerical solutions for carrying out surveying in civil engineering field.
CLO5	To get introduced to modern advanced surveying techniques involved such as remote sensing, Total station, GPS etc.

Course Content

Surveying – Definition – Objectives and Principles – Types of surveying - Conventional and Advanced Surveying – Drawing practices – Map – Plan – Scale – Layout – Field record – Plans of survey – Standard and Calibration – Survey marks

Datums – Reference planes – Geoid – Ellipsoid – Coordinate systems – Coordinate Transformation – Maps – Map Projections and Transformations – Coordinate systems and Map projections of various countries

Conventional Surveying procedures – Data acquisition – Chain – Tape – Theodolite – Levelling – Output, Applications and importance

Modern Surveying procedures – Data acquisition – Remote Sensing -

Photogrammetry – EDMs – Space Geodesy – GPS/GNSS – VLSI – Doppler methods – Output, Applications and importance

Digital data and Software – Data structure – Data flow – Exchange and Standards –

Creation and gathering of data – Management of Data – Digital image processing – Future – Land surveying Law and Administration – GIS – Survey resource systems

References

1.	Duggal, S.K. Surveying Vol. I and II, Tata McGraw Hill, 2004.
2.	Punmia, B.C. Surveying Vol.I and II, Standard Publishers, 1994.
3.	Arora, K. R. Surveying Vol. I and II, Standard Book House, 1996

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Carry out preliminary surveying in the field of civil engineering
CO2	Plan a survey, taking accurate measurements, field booking, plotting and adjustment of traverse
CO3	Use various conventional instruments involved in surveying with respect to utility and precision
CO4	Plan a survey for applications such as road alignment and height of the building
CO5	Undertake measurement and plotting in civil engineering

CEMI12 STRUCTURAL ANALYSIS AND DESIGN

Course Code	**:**	CEMI12
Course Title	**:**	**Structural Analysis And Design**
Type of Course	**:**	MI
Corequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce the concept of structural elements and their analysis
CLO2	To understand and design simple axially loaded RC columns and beams
CLO3	To understand and design simple axially loaded Steel columns and beams

Course Content

Introduction to reinforced concrete elements – Analysis and design of axially loaded column - Analysis and design of determinate beams

Analysis and design of laterally restrained and unrestrained steel beams

Analysis and design of axially loaded compression member

Design of lap and butt joints using bolts ad welds

References

1.	Dayaratnam, P., Design of Reinforced Concrete Structures, Oxford & IBH Publishers & Co., New Delhi, 2005.
2.	IS456-2006 Code of practice for Plain and reinforced concrete code of practice.
3.	Bhavikatti, S.S., Design of Steel Structures, I.K. International Publishing House Pvt. Ltd., New Delhi, 2010
4.	IS 800 - 2007, Code of practice for general construction in steel, Bureau of Indian Standards, New Delhi.
5.	SP6 (1)-1964, IS hand book for structural Engineers. Bureau of Indian Standards, New Delhi.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Analyse and design simple structural elements
CO2	Analyse and design simple axially loaded RC columns and beams
CO3	Analyse and design simple axially loaded Steel columns and beams

CEMI13 SOILS AND FOUNDATIONS

Course Code	**:**	CEMI13
Course Title	**:**	**Soils And Foundations**
Type of Course	**:**	MI
Corequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	Explain the origin, formation, and classification of different soil types, including the structure and properties of clay minerals and problematic soils.
CLO2	Describe the principles of soil compaction and consolidation, and evaluate their effects on soil suitability for foundations and other engineering applications.
CLO3	Assess the stability of soil slopes, understand various failure mechanisms, and apply knowledge to analyze infinite and finite slopes and design appropriate slope protection measures.
CLO4	Interpret the results of soil exploration tests to inform engineering decisions.
CLO5	Identify different types of foundations design appropriate foundation types based on soil conditions and project requirements.

Course Content

Module 1 : Origin, formation and classification of Soil – Structure and properties of clay minerals - Problematic Soils – Permeability and seepage – Permeability testing of soils and applications

Module: 2 Introduction to compaction and Consolidation – suitability of soil for foundations – methods of ground improvement

Module 3: Soil slopes and its failure mechanisms – Types - infinite slopes – finite slopes – slope protection measures

Module 4:Soil exploration and its importance - Plate load test, static and dynamic penetrations tests - geophysical explorations

Module 5: Types and Choice of foundation – Combined Foundation – Mat foundation – Types of piles and sheet piles – Under reamed piles - machine foundation.

References

1.	Murthy, V.N.S, A text book of Soil Mechanics and Foundation Engineering, UBS Publishers & Distributors Pvt. Ltd., New Delhi 1999.
2.	Punmia, B.C., Soil Mechanics and Foundation Engineering, Laxmi Publications Pvt. Ltd., New Delhi, 1995.
3.	Gopal Ranjan and Rao, Basic and Applied Soil Mechanics, New Age International (P) Limited, New Delhi, 2002.
4.	Robert D. Holtz, William D. Kovacs and Thomas C. Sheahan, An Introduction to Geotechnical Engineering, Pearson, 2013.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Students will be able to classify various soil types.
CO2	Students will be able evaluate appropriate soil compaction methods for different soil types.
CO3	Students will be to analyze soil slope stability and understand failure mechanisms
CO4	Students will be able to interpret the data obtained, and integrate the findings into practical engineering solutions for construction and soil improvement.
CO5	Students will be able to determine soil suitability for foundations and other engineering applications.

CEMI14 TRANSPORTATION SYSTEMS

Course Code	**:**	CEMI14
Course Title	**:**	**Transportation Systems**
Type of Course	**:**	MI
Corequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To study about the geometric design of highways
CLO2	To know about pavement materials and design

CLO3	To study about the types and functions of track, junctions and railway stations.
CLO4	To learn about the aircraft characteristics, planning and components of airport.
CLO5	To study about the types and components of docks and harbours

Course Content

Highway Engineering - Classification of roads, highway alignment and surveys; Geometric Design - Cross section elements, sight distance, design of horizontal and vertical alignment.

Pavement Materials and Design - Specifications and tests on pavement materials, pavement design factors, design of flexible and rigid pavements.

Railway Engineering - Location surveys and alignment - Gauges - Components of Permanent way; Track Junctions - Points and crossings - Railway stations and yards.

Airport Engineering - Aircraft characteristics - Airport obstructions and zoning - Runway - Taxiways and aprons - Terminal area planning

Docks and Harbours - Layout and planning principles - Breakwaters – Docks - Wharves and quays - Navigational aids.

References

1.	Khanna, S.K and Justo, C.E.G., Highway Engineering, Nem Chand and Bros.Roorkee (U.P), 1998.
2.	M.M. Agarwal, Railway Engineering, Prabha & Co. 2007.
3.	Khanna, S.K. and Arora, M.G. Airport Planning and Design, Nemchand and Bros. 1999.
4.	Oza and Oza, Elements of Dock and Harbour Engineering, Charotar Publishing House, 1996.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Design cross section elements, sight distance, horizontal and vertical alignment
CO2	Determine the characteristics of pavement materials
CO3	Plan the layout of railway terminals
CO4	Apply principles of airport planning
CO5	Implement the layout of harbours

CEMI15 WATER AND AIR POLLUTION MANAGEMENT

Course Code	**:**	CEMI15
Course Title	**:**	**Water And Air Pollution Management**
Type of Course	**:**	MI
Corequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To teach the basic characteristics of water both qualitatively and quantitatively
CLO2	To familiarize the water distribution system and the water treatment processes
CLO3	To provide adequate knowledge about wastewater characteristics and its treatment processes
CLO4	To give an idea about the disposal of wastewater into water bodies and their effects on river systems
CLO5	To study the various treatment techniques for industrial wastewater and understand the concepts of air pollution and its control measures

Course Content

Physical, chemical and biological characteristics of water - Water analysis - IS and WHO standards - Requirements of water supply – Per-capita water demand - Sources of water- Water treatment plants - Process of treatments; Water distribution - Methods of distribution systems-Layouts - Analysis of distribution networks; Wastewater characteristics - Wastewater treatment - Primary treatment - Secondary treatment; Disposal standards - Self-purification of rivers - Streeter Phelps equation - Oxygen sag curve; Industrial wastewater treatment - Methods - Air pollution – Effects - Stack emission - Automobile exhaust - Control devices.

References

1.	Manual on Water supply and Treatment – CPHEEO,1999
2.	Peavy H. S., Rowe D. R. and TchobanoglousG., Environmental Engineering, McGrawHill, New York, 1985.
3.	Birdie, G.S. and Birdie, Water Supply and Sanitary Engineering, Dhanpat Rai & Sons, 1992.
4.	Duggal, K.N. Elements of Environmental Engineering, S.Chand& Co, 2002. 5. Punmia B.C, Ashok Jain & Arun Jain, Water Supply Engineering, Laxmi Publications, Pvt. Ltd., New Delhi, 2004.
5.	Punmia B.C, Ashok Jain & Arun Jain, Water Supply Engineering, Laxmi Publications, Pvt. Ltd., New Delhi, 2004.
6.	Metcalf and Eddy, Wastewater Engineering, Collection, Treatment and Disposal, Tata McGraw Hill, Inc., New York, 2005

Course Outcomes (CO)

At the end of the course student will be able to

CO1	evaluate the characteristics of water
CO2	suggest suitable methods for water treatment
CO3	prepare a layout of water distribution network.
CO4	characterize wastewater and apply suitable treatment process
CO5	recommend air pollution control devices

CEMI16 IRRIGATION ENGINEERING AND MANAGEMENT

Course Code	**:**	CEMI16
Course Title	**:**	**Irrigation Engineering And Management**
Type of Course	**:**	MI
Corequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the basic types of irrigation, irrigation standards and crop water assessment
CLO2	To know the irrigation management practices of the past, present and future
CLO3	To study the different aspects of design of hydraulic structures
CLO4	To provide knowledge on various hydraulic structures
CLO5	To learn optimizing irrigation, on-farm management, and participatory practices.

Course Content

Irrigation – Need and mode of irrigation – Merits and demerits of irrigation – Crop and crop seasons – consumptive use of water – Duty – Factors affecting duty – Irrigation efficiencies – Planning and Development of irrigation projects. Canal irrigation – Lift irrigation – Tank irrigation – Flooding methods – Merits and demerits – Sprinkler irrigation – Drip irrigation

Weirs – elementary profile of a weir – weirs on pervious foundations - Types of impounding structures - Percolation ponds – Tanks, Sluices and Weirs – Gravity dams – Earth dams – Arch dams – Spillways – Factors affecting location and type of dams – Forces on a dam – Hydraulic design of dams.

Alignment of canals – Classification of canals – Canal drops – Hydraulic design of drops – Cross drainage works – Hydraulic design of cross drainage works – Canal Head works – Canal regulators – River Training works.

Need for optimisation of water use – Minimising irrigation water losses – On farm development works – Participatory irrigation management – Water users associations– Changing paradigms in water management – Performance evaluation

References

1.	Asawa, G.L., “Irrigation Engineering”, New Age International Publishers, 2000
2.	Punima B.C. & Pande B.B .Lal Irrigation and Water Power Engineering, Laxmi Publishing, New Delhi 2007
3.	Michael, A.M, Irrigation Theory and Practical, Vikas Publishing Pvt Ltd, 2006

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Find the crop water requirement for various crops in the command area.
CO2	Understand the complete design of Dams and channel systems.
CO3	Understand the different types of cross drainage works.

CO4	Understand the participatory irrigation management
CO5	Capable of designing reservoir storage characteristics

CEMI17 QUANTITY ESTIMATION AND VALUATION

Course Code	**:**	CEMI17
Course Title	**:**	**Quantity Estimation And Valuation**
Type of Course	**:**	MI
Corequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To know the importance of preparing the types of estimates under different conditions
CLO2	To know about the rate analysis and bill preparations
CLO3	To study about the specification writing
CLO4	To understand the valuation of land and buildings

Course Content

Preparation of detailed estimates - Preparation of specifications report accompanying the estimate Approximate methods of Costing - types of estimate - costing for various structures - rate analysis - rate for material and labour - schedule of rates -data sheets - abstract estimate. Values and its kinds - Valuation - purpose- scope - methods - land and building method - Factors affecting the value of plot and building - depreciation - Valuation of residential building with case study.

References

1.	Dutta. B.N, Estimating and Costing in Civil Engineering: Theory and Practice including specifications and valuation, UBS Publishers and distributors, 27th revised edition.
2.	Chakraborthi.M, Estimating, Costing, Specification & Valuation in Civil Engineering, UBS Publishers and distributors, 2006
3.	Bhasin, P.L., Quantity Surveying, 2nd Edition, S.Chand& Co., 2000.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Apply different types of estimates in different situations
CO2	Carry out analysis of rates and bill preparation at different locations
CO3	Demonstrate the concepts of specification writing
CO4	Carry out valuation of assets

ADVANCED LEVEL COURSES FOR B.TECH. (HONOURS)

CEHO10 DYNAMICS OF STRUCTURES

Course Code	**:**	CEHO10
Course Title	**:**	**Dynamics of Structures**
Type of Course	**:**	HO
Prerequisites	**:**	CEPC10, CEPE66
Contact Hours	**:**	46
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce the concepts of dynamic loading and to study the dynamic response of SDOF, MDOF and continuous systems subjected to different types of dynamic loads.
CLO2	To learn free and forced vibration response of structural systems.
CLO3	To familiarize students with mathematical models representing real time problems of discrete and continuous vibratory systems.
CLO4	To make students understand the principle of virtual displacements.
CLO5	To expose students to the concept of resonance.

Course Content

Introduction; SDOF system: Derivation of Equation of Motion, Free and Force vibration of undamped and viscously damped system, response due to Harmonic excitation; analysis under general forcing function – periodic and pulse loading

Numerical techniques to determine response of SDOF system; Elastic Response Spectra: Earthquake excitation; Generalized SDOF system

Two degrees of freedom system: Derivation of equation of motion, synchronous motion; Free Vibration – Natural frequencies and mode shapes, Principal coordinates, Semi-definite system, Tuned vibration absorber

Multi-degree of freedom system: Mass and stiffness matrices for discrete system;

Orthogonality of mode shapes; mode superposition method; Damping in structures – Classical and non-classical damping matrix; Free and Forced response; Determination of Natural Frequencies and mode Shapes – Dunkerley's Formula; Holzer method; Matrix iteration method; Jacobi's method; Rayleigh's quotient

Elements of analytical dynamics: Hamilton's principle – Lagrange's Equation – Virtual work

Continuous system: Relation between discrete and continuous system; axial vibration of bar and bending vibration of beam; Effects of shear deformation and rotary inertia; Free vibration; modal analysis; Approximate methods – Rayleigh-Ritz method; Assumed mode. Introduction to FEM for bar and beams – element mass and stiffness matrices; assembly; equation of motion for complete system

References

1	Mario Paz, Structural Dynamics, CBS, Publishers, 1987.
2	Roy R Craig, Jr., Structural Dynamics, John Wiley & Sons, 1981.
3	Chopra A.K. "Dynamics of Structures Theory and Application to Earthquake Engineering" Pearson Education, 2001.
4	Clough and Penzien, Dynamics of Structures, McGraw Hill, 5th Edition, 1975.
5	Srinivasan Chandrasekaran, Dynamic Analysis
6	Structures, Springer, 2015.
7	Elements of Vibration Analysis by Leonard_Meirovitch

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Apply the concepts of dynamic systems
CO2	Identify, formulate and solve dynamic response of SDOF
CO3	Identify, formulate and solve dynamic response of MDOF
CO4	Analyze continuous systems subjected to different types of dynamic loads
CO5	Identify, formulate and solve free and forced vibrations response of structural systems

CEHO11 FINITE ELEMENT ANALYSIS

Course Code	**:**	CEHO11
Course Title	**:**	**Finite Element Analysis**
Type of Course	**:**	HO
Prerequisites	**:**	CEPE66
Contact Hours	**:**	46
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To study the modelling aspects of Discrete and Continua elements
CLO2	To develop equilibrium equation and solving problem through Direct stiffness method for discrete elements
CLO3	To study the strain – displacement and linear constitutive relation
CLO4	To derive Element Stiffness Matrix through various shape functions for 1D and 2D elements.
CLO5	To study and apply the 2-D isoparametric elements
CLO6	To apply equilibrium equations, strain displacement relation, linear constitutive relation in practical problems.

Course Content

Introduction to Discrete and Continua elements – Discrete Elements - Direct stiffness method - Special characteristics of stiffness matrix - Assemblage of elements – Boundary condition & reaction - 2D – truss element - 2D - beam element - Analysis of framed Structures - Gauss elimination and LDLT decomposition. Basic steps in finite element analysis.

Differential equilibrium equations - strain displacement relation - linear constitutive relation - special cases - Principle of stationary potential energy - application to finite element methods - Some numerical techniques in finite element Analysis

Continua Elements - Displacement models - convergence requirements. Natural coordinate systems - Shape function. Interpolation function. Linear and quadratic elements - Lagrange & Serendipity elements. Strain displacement matrix - element stiffness matrix and nodal load vector

Two dimensional isoparametric elements - Four noded quadrilateral elements - triangular elements. Computation of stiffness matrix for isoparametric elements - numerical integration (Gauss quadrature) Convergence criteria for isoparametric elements.

Analysis of plate bending- displacement functions - plate bending Elements. Plane stress and plane strain analysis: Triangular elements - Rectangular elements – Example problem using any general-purpose finite element software

(Assignment includes Modelling and Analysis of structural members using any general-purpose finite element software)

References

1	Krishnamoorthy, C. S, Finite Element Analysis - Theory and Programming, McGraw - Hill, 1995.
2	David Hutton, Fundamentals of Finite Element Analysis, Tata McGraw Hill Publishing Company Limited, New Delhi, 2005.
3	G.R. Liu and S.S.Quek, Finite Element Method: A Practical Course, Butterworth-Heinemann; 1st edition (21 February 2003)
4	Chennakesava R. Alavala Finite Element Methods: Basic Concepts and Applications, Prentice Hall Inc., 2010.
5	R. T. Chandrupatla and A. D. Belegundu, Introduction to Finite Elements in Engineering, PHI Learning Pvt Ltd, New Delhi, 1997.
6.	S. S. Bhavikatti, Finite Element Analysis, New Age Publishers, 2007.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Demonstrate the differential equilibrium equations and their relationship
CO2	Apply numerical methods to FEM
CO3	Demonstrate the displacement models and load vectors
CO4	Compute the stiffness matrix for isoperimetric elements
CO5	Analyze plane stress and plane strain problems

CEHO12 THEORY OF ELASTICITY AND INTRODUCTION TO PLASTICITY

Course Code	**:**	CEHO12
Course Title	**:**	**Theory of Elasticity and Introduction to Plasticity**
Type of Course	**:**	HO
Prerequisites	**:**	CEPC10

Contact Hours	**:**	46
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn about the concept of deformation, stress, strain and constitutive relations of solids
CLO2	To understand practically useful stress definitions such as principal, hydrostatic, octahedral etc
CLO3	To know the usage of Airy Stress functions and solution to problems using the approach
CLO4	To understand the behaviour of non-circular and open sections in torsion
CLO5	To gain a basic introduction to the plastic behaviour in materials and application of failure theories of brittle and ductile materials

Course Content

Basic concepts of deformation of bodies – deformation gradient- Tensor notations of stress and strain in 3D field - Traction - Engineering and Cauchy stress and Green- Lagrange Strains - Cauchy form of equilibrium equation - Transformation of stress and strain in a 3D field - Equilibrium equations in 2D and 3D Cartesian coordinates Compatibility equations - Stresses: Principal, Octahedral, Hydrostatic and deviatoric

- Derivation of Constitutive law - reduction to isotropic and uniaxial case

Plane stress and plane strain problems - 2D problems in Cartesian coordinates as applied to beam bending using Airy's stress function and examples - Problems in 2D - stress concentration in holes - Circular disc subjected to diametral compressive loading - semi-infinite solid subjected to different types of loads – Analysis of Thick Cylinders

Torsion of non-circular sections - St. Venant's theory – Torsion of elliptical sections - Torsion of triangular sections - Prandtl's membrane analogy - Torsion of rolled profiles - Torsion of thin walled tubes

Plasticity – Introduction - Reasons of plasticity - slip lines - Plastic stress-strain relations - Flow rules (associated and non associated) - Different hardening rules - Yield criteria for ductile and brittle materials - Graphical representation of yield criteria

References

1	Srinath, L.S., Advanced Mechanics of Solids, Tata McGraw Hill, 2010
2	Schmidt, R.J. and Boresi, A.P., Advanced Mechanics of Materials, Wiley, 2002
3	Hibbeler, R.C., Mechanics of Materials, Pearson, 2016
4	Timoshenko, S.P. and Gere, J.M. Mechanics of Materials, Tata McGraw Hill, 1992
5	Rees, D.W.A., Basic Engineering Plasticity, Butterworth-Heinemann, 2006

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Relate various stress and strain measures and perform transformation between different bases.

CO2	Determine principal, hydrostatic and octahedral stresses for given stress state
CO3	Obtain the solution to classical problems using the Airy stress function approach
CO4	Analyse non-circular and open sections subjected to torsion
CO5	Apply hardening rules in the plastic range and determine the failure of brittle and ductile materials using various failure theories.

CEHO13 NONLINEAR ANALYSIS OF STRUCTURES

Course Code	**:**	CEHO13
Course Title	**:**	**Nonlinear Analysis of Structures**
Type of Course	**:**	HO
Prerequisites	**:**	36
Contact Hours	**:**	CEPC15
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the factors influencing nonlinear response of structures
CLO2	To study about the elastic and plastic analysis of structures
CLO3	To learn the various techniques on nonlinear analysis of structures
CLO4	To provide the knowledge on solution techniques

Course Content

Introduction – Factors influencing nonlinear response of structures – Geometrical effect, Material effects, Instability phenomena – Snap through, Bifurcation, Post buckling behaviour

Elastic-Plastic analysis of trusses – Elastic-Plastic analysis of beams – Elastic- Plastic analysis of frames

Geometrically nonlinear static analysis of trusses – Member force-deformation relationships – Member tangent stiffness matrices – System equilibrium equations Solution techniques - static analysis – Linearized incremental procedures – Iterative techniques – Detection of instability

Geometrically nonlinear static analysis of frames – Large rotations – Analysis of individual members – Member tangent stiffness matrices – Solution techniques

References

1	Fertis, D.G, Non-linear Mechanics,CRC Press,1999.
2	Reddy.J.N, Non-linear Finite Element Analysis, Oxford University Press, 2008
3	Sathyamoorthy.M, Nonlinear Analysis of Structures,CRC Press,2010.
4	Nonlinear Structures, Majid, K.I., John Wiley and Sons, Inc., New York, 1972

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Identify the factors affect the nonlinear response of structures
CO2	Analyze the elastic-plastic properties of trusses, beams and frames

CO3	Carry out various methods on analysis of nonlinear response of structure
CO4	Apply the solution techniques for nonlinear static analysis of frames and members
CO5	To perform nonlinear analysis to find the collapse of large structures

CEHO14 THEORY OF TRAFFIC FLOW

Course Code	**:**	CEHO14
Course Title	**:**	**Theory of Traffic Flow**
Type of Course	**:**	HO
Prerequisites	**:**	CEPC19
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To be introduced to traffic flow theory.
CLO2	To study macroscopic modelling
CLO3	To learn microscopic modelling
CLO4	To study car following models
CLO5	To learn the fundamentals of ITS.

Course Content

Traffic stream parameters - Fundamental diagram of volume-speed-density surface. Counting and Interval Probability distributions. Gap acceptance concepts and their application.

Macroscopic models - Heat flow and fluid flow analogies - Shock waves and bottleneck control approach.

Microscopic models - Application of queuing theory - Queue discipline - Waiting time in single channel queues and extension to multiple channels.

Linear and non-linear car following models - Determination of car following variables - Acceleration noise.

Intelligent Transportation Systems - Area Traffic Control – Automatic Toll Collection – Smart Cards – Collision Detection System.

References

1	Diheng Ni., Traffic Flow Theory, Butterworth Heinemann (Elsevier)., 2016.
2	TRB, Traffic Flow Theory - A Monograph, SR165, 1975.
3	Burrough P.A. and Rachel A. McDonell, Principles of Geographical Information Systems, Oxford Publication, 2004.
4	Sussman, J. M., Perspective on ITS, Artech House Publishers, 2005.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Analyze the traffic stream parameters

CO2	Demonstrate fluid flow modeling
CO3	Apply the queuing theory
CO4	Implement car following models
CO5	Define the significance of ITS under Indian conditions.

CEHO15 PAVEMENT CONSTRUCTION AND MANAGEMENT

Course Code	**:**	CEHO15
Course Title	**:**	**Pavement Construction and Maintenance**
Type of Course	**:**	HO
Prerequisites	**:**	CEPC19
Contact Hours	**:**	46
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the concept of earthwork and subgrade formation for constructing pavements.
CLO2	To learn the concept of flexible pavement layer construction.
CLO3	To learn the concept of cement concrete pavement and its joints
CLO4	To analyse the defects in road construction and general pavement failures
CLO5	To understand the concept and of Pavement maintenance

Course Content

Earthwork and Subgarde: Earthwork, compaction and construction of embankments - specifications of materials, construction methods and field control checks, Subgrade construction, construction of surface and sub-surface drainage system; Soil Stabilized Pavement Layers: soil-aggregate mixes and compaction; soil-cement and soil-lime stabilisation methods.

Flexible pavement construction: Construction procedure Subbase (Granular sub base), Drainage layer, Base course-WBM, WMM, Lime stabilized, cement stabilized , Bituminous mix – Binder course and wearing course, its selection, its gradation, compaction, density requirements and construction procedure.

Cement Concrete Pavement Layers: Specifications and method of Dry lean concrete and Pavement quality concrete construction; Construction of various types of joints Quality control tests; Interlocking Concrete Block Pavement (ICBP) - procedure of laying, requirements, Pattern of blocks, Strength requirement.

Pavement Evaluation - Pavement Distress - Functional and structural condition of pavements, Pavement distress survey, Functional condition evaluation of pavements-Roughness, Skid Resistance. Structural evaluation of pavements - non destructive testing, Benkelman beam and Falling Weight Deflectometer, Pavement strengthening based on deflection as per IRC.

Pavement Maintenance- Importance of maintenance – Types of Maintenance-Preventive maintenance. Repair of pavement defects, Preventive maintenance of

road drainage system, pavements and other components of road. Preparation of existing pavement – patching, profile correction, Special measures to deal with reflection cracks in pavement layers, slipperiness of surface, etc. Recycling Techniques in Bituminous Pavements, Full Depth Reclamation.

References

1	Kandhal, Veeraragavan, Rajan, *Bituminous Road Construction in India*, PHI Learning PVT, India, 2nd Edition, 2023.
2	P. Purushothama Raj, *Ground Improvement Techniques*, Laxmi Publications (P) Ltd., New Delhi, 2016.
3	Sandipan Goswami, *Pavement Engineering: Design, Construction, Maintenance*, PHI Publication, 2022.
4	W.Ronald Hudson, Ralph Haas and Zeniswki, *Modern Pavement Management, Mc* Graw Hill and Co, 1994.
5	Relevant IRC codes and Ministry Specifications.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	carry out the construction control and quality control checks of subgrade and stabilised layers.
CO2	carry out the construction of subbase, base and wearing courses in flexible pavements.
CO3	understand the construction of interlocking block pavements, quality control tests; construction of various types of joints.
CO4	understand various distresses and the evaluation of pavements
CO5	propose suitable maintenance and rehabilitation strategies for pavement failures.

CEHO16 DYNAMICS OF SOILS AND FOUNDATIONS

Course Code	**:**	CEHO16
Course Title	**:**	**Soil Dynamics and Foundations**
Type of Course	**:**	HO
Prerequisites	**:**	CEPC20
Contact Hours	**:**	46
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To interpret the concept of dynamics in Geotechnical Engineering.
CLO2	To predict liquefaction and suggest mitigation.
CLO3	To recognize the significance of soil-structure interaction
CLO4	To apply the principles of dynamics for the design of machine foundation
CLO5	To learn the principles and techniques for designing machine foundations, including vibration absorption and isolation methods.

Course Content

Introduction - nature of dynamic loads - stress conditions on soil elements under earthquake loading - dynamic loads imposed by simple crank mechanism - type of machine foundations - special considerations for design of machine foundations.

Theory of vibration: general definitions - properties of harmonic motion - free vibrations of a mass- spring system - free vibrations with viscous damping - forced

vibrations with viscous damping - frequency dependent exciting force - systems under transient forces - Raleigh's method - logarithmic decrement - determination of viscous damping - principle of vibration measuring instruments - systems with two degrees of freedom.

Criteria for a satisfactory machine foundation - permissible amplitude of vibration for different type of machines - methods of analysis of machine foundations - methods based on linear elastic weightless springs - methods based on linear theory of elasticity (elastic half space theory) - methods based on semi graphical approach - degrees of freedom of a block foundation - definition of soil spring constants - nature of damping - geometric and internal damping - determination of soil constants – methods of determination of soil constants in laboratory and field based on IS code provisions.

Vertical, sliding, rocking and yawing vibrations of a block foundation - simultaneous rocking, sliding and vertical vibrations of a block foundation - foundation of reciprocating machines - design criteria - calculation of induced forces and moments - multi-cylinder engines - numerical example (IS code method).

Foundations subjected to impact loads - design criteria - analysis of vertical vibrations - computation of dynamic forces - design of hammer foundations (IS code method) - vibration isolation - active and passive isolation - transmissibility - methods of isolation in machine foundations.

References

1	Shamsher Prakash, V K Puri, "Foundations for Machines: Analysis and Design", John Wiley & Sons, 1988.
2	Swami Saran, "Soil Dynamics and Machine Foundation", Galgotia publications Pvt. Ltd., New Delhi 1999.
3	K.G. Bhatia, "Foundations for Industrial Machines: Handbook for Practising Engineers", CRC Press, London, 2009.
4	Krammer.S.L, "Geotechnical Earthquake Engineering", prentice hall, international series, Pearson Education (Singapore) Pvt. Ltd., 2004.
5	Kameswara Rao, "Vibration Analysis and Foundation Dynamics", wheeler Publishing, New Delhi, 1998.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	To interpret the principles of dynamics in Geotechnical Engineering.
CO2	To predict liquefaction and suggest measures for its mitigation.
CO3	To reason the response of any soil-structure system.

CO4	To apply the principles of soil dynamics.
CO5	To become the proficiency in designing machine foundations and implementing vibration isolation techniques based on dynamic analysis.

CEHO17 SOIL EXPLORATION AND FIELD TESTING

Course Code	**:**	CEHO17
Course Title	**:**	**Soil Exploration and Field Testing**
Type of Course	**:**	HO
Corequisites	**:**	CEPC20
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To recall the various soil investigation techniques
CLO2	To familiarize students with Geophysical techniques
CLO3	To make students understand the applications of Pressure Meter and dilatometer Testing
CLO4	To make students understand the drilling in difficult subsoil conditions
CLO5	To familiarize students with Instrumentations used in soil engineering

Course Content

Principles of exploration; Modern methods of boring and sampling, advanced sampling techniques, offshore sampling; stabilization of boreholes; Preservation and transportation of samples; Basic Field tests - penetration tests - Field vane shear - plate load test – monotonic and cyclic; field permeability tests.

Geophysical exploration and interpretation - seismic and electrical methods; Electrical Resistivity Methods: Principle, Resistivity of soils and rocks, Resistivity Technique- Wenner and Schlumberger arrangements, Electrical Soundings, Methods of electrical resistivity profiling. Cross bore hole, single bore hole – up hole -down hole method. Analysis and interpretation of field test data

Pressure Meter Testing of Soils and Weak Rocks: Menard pressure meter equipment, Probe calibration and corrections, Limit pressure, Creep pressure, Tests in soils and weak rocks, Interpretation of test data, Pressure meter modulus of soils & weak rocks. Dilatometer Testing of Soils: Equipment and procedure of testing, Interpretation of test data, Geotechnical parameters of clay- OCR, k0, un-drained shear strength, soil stiffness, coefficient of consolidation, Geotechnical parameters of clay- friction angle, state parameter, soil stiffness,

Drilling in difficult subsoil conditions - various drilling techniques and limitations - In-situ shear Strength of Jointed Rocks: Equipment and test procedure, interpretation for peak and residual strength of rock mass. Measurement of In-situ Stresses in Rocks: Flat jack technique, Hydro-fracturing method - In-situ Deformation Modulus of Jointed Rocks : Goodman Jack test, Plate jacking test, Plate jacking test down the drill hole, radial jacking test etc., interpretation of test data. Post Failure Testing of Rocks: Servo-controlled uni-

axial and tri-axial testing of different rock types, effect of confining pressure, brittle-ductile transition, effect of L/D ratio, Cyclic testing of rock cores, analysis and interpretation of test data

Instrumentation in soil engineering, strain gauges, resistance and inductance type, load cells, earth pressure cells, settlement and heave gauges, pore pressure measurements - slope indicators, sensing units, case studies.

References

1.	Dunnicliff, J. and Green, G.E, Geotechnical Instrumentation for Monitoring Field Performance, John Wiley & Sons, 1982.
2.	GopalRanjan and Rao, A.S.R, Basic and Applied Soil Mechanics, Wiley Eastern Limited,1991
3.	Lunne, T., Robertson, P.K. and Powell, J.J.M, Cone Penetration Testing in Geotechnical Practice, Blackie Academic & Professional, 1997.
4.	Compendium of Indian Standards on Soil Engineering Parts 1 and II 1987 – 1988
5.	All related ASTM codes and Eurocode 7 - Part 2.
6.	Clayton, C. R. I., Matthews, M. C. and Simons, N. E. (1995) Site Investigation (Second Edition). Oxford, Blackwell Sciences..
7.	Hunt, R. E. (2005) Geotechnical Engineering Investigation Handbook (Second Edition), CRC Press Taylor & Francis Group
8.	Schnaid, F. (2009) In Situ Testing in Geomechanics : The Main Tests. Taylor & Francis
9.	Simons, N., Menzies, B. and Matthews, M. (2002) A Short Course in Geotechnical Site Investigation. Thomas Telford.
10.	Hudson, J. A., Harrison, J. P., “Engineering Rock Mechanics”, Pergamon Press 1997
11.	Ramamurthy, T., “Engineering in Rocks for Slopes, Foundations and Tunnels”, Prentice Hall. 2007

Course Outcomes (CO)

At the end of the course student will be able to

CO1	To extract samples as per requirement and perform field and laboratory tests.
CO2	To understand the practical significance of the results obtained from geophysical test methods.
CO3	To be familiar with Pressure Meter and dilatometer testing and interpretation of test data.
CO4	To be exposed to measurement of in-situ stresses in rocks and post failure testing of rocks
CO5	To be exposed to Geotechnical Instrumentation for field monitoring

CEHO18 PHYSICO-CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT

Course Code	**:**	CEHO18
Course Title	**:**	**Physico-Chemical Processes for Water nd Wastewater Treatment**
Type of Course	**:**	HO
Corequisites	**:**	CEPC21

Contact Hours	**:**	46
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn the physical, chemical and biological characteristics of water and wastewater
CLO2	To provide an understanding of various physicochemical methods for treatment of water and wastewater
CLO3	To explain the limitations, advantages and disadvantages of each unit operations and processes
CLO4	To study the principle and design of the physical and chemical treatment units used for the removal of undesirable constituents (contaminants) from water and wastewater
CLO5	To describe the various advanced treatment systems for the removal of specific constituents and its limitations

Course Content

Water Quality - Physical, Chemical and Biological Parameters of Water - Water Quality Requirement - Potable Water quality Standards - Wastewater Effluent Standards - Water Quality Indices; Water Purification in Natural Systems; Primary, Secondary and Tertiary Treatment - Unit Operations - Unit Processes; Particle Separation Processes - Coagulation and Flocculation Processes - Particle Surface Charge - Surface Potential and Stability of Colloidal Dispersions; Sedimentation and Flotation Processes - Gravity Thickeners - Clarifiers and Flotation Systems - Filtration and Ultrafiltration Processes - Modeling Approaches for Rapid Sand Filters - Solute Separation Processes - Gas Transfer Processes - Diffused and Surface Aeration and Air Stripping of Volatile Contaminants in Packed Tower - Adsorption and Ion Exchange Processes - Sorption Isotherm Models and Rates Considerations - Sorption in Completely Mixed and Packed Bed Reactors - Precipitation Processes - Reverse Osmosis and Electro dialysis - Species Transformation Processes - Chemical Oxidation / Reduction Processes - Disinfection using Chlorine and UV - Advanced Oxidation Process.

References

1.	Weber, W.J. Physicochemical processes for water quality control, John Wiley and sons, Newyork, 1983.
2.	Peavy, H.S., Rowe, D.R., Tchobanoglous, G. Environmental Engineering, McGraw Hills, New York 1985.
3.	Metcalf and Eddy, Wastewater engineering, Treatment and Reuse, Tata McGraw-Hill, New Delhi, 2003.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	differentiate the physical, chemical and biological characteristics of water and wastewater
CO2	evaluate various physical and chemical treatment options for treatment of water and wastewater
CO3	explain the mechanism behind the treatment processes and their advantages and

	disadvantages
CO4	design various physico- chemical units for the treatment of water and wastewater
CO5	analyze and design the advanced treatment systems for the removal of specific constituents

CEHO19 BIOLOGICAL TREATMENT OF WASTEWATER

Course Code	**:**	CEHO19
Course Title	**:**	**Biological Treatment of Wastewater**
Type of Course	**:**	HO
Corequisites	**:**	CEPC21
Contact Hours	**:**	46
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn the fundamentals of process kinetics and enzyme reactions
CLO2	To know the concepts of various bioreactors and its application in biological treatment of wastewater
CLO3	To study about various biological treatment processes and its operations for the wastewater treatment
CLO4	To provide the knowledge about the kinetics of biological growth and its application in the design of biological reactors
CLO5	To explain the design principles and operational problems involved in various biological treatment processes

Course Content

Constituents of Wastewaters - Sources - Significant Parameter - Fundamentals of Process Kinetics - Zero Order - First Order - Second Order Reactions - Enzyme Reactions - Bio Reactors - Types - Classification - Design Principles - Design of Wastewater Treatment Systems - Primary - Secondary and Tertiary Treatments - Evaluation of Biokinetic Parameters - Activated Sludge and its Process - Modifications - Biological Nitrification and Denitrification –- Attached Growth Biological Treatment Systems -Trickling Filters - Rotating Biological Contactors - Waste Stabilization Ponds and Lagoons- Algae and Bacteria Symbiosis - Aerobic Pond - Facultative Pond - Anaerobic Ponds - Polishing Ponds - Aerated Lagoons - Anaerobic Processes - Process Fundamentals - Standard, High Rate and Hybrid Reactors - Anaerobic Filters-Expanded / Fluidized Bed Reactors - Upflow Anaerobic Sludge Blanket Reactors - Expanded Granular Bed Reactors - Two Stage / Phase Anaerobic Reactors -Membrane Bioreactors – Sludge Digestion - Sludge Disposal.

References

1.	Benefield, L.D. and Randall C.W. Biological Processes Design for wastewaters, Prentice-Hall, Inc. Eaglewood Cliffs, 1982
2.	Grady Jr. C.P.L and Lin H.C. Biological wastewater treatment: Theory and Applications
3.	Metcalf & Eddy, Inc. Wastewater Engineering, Treatment and Reuse. 3rd Edition, Tata McGraw-Hill, New Delhi, 2003
4.	*Arceivala, S. J., and Asolekar, S.R., Wastewater Treatment for Pollution Control. 3rd*

	Edition, McGraw-Hill Education (India) Pvt. Ltd., New Delhi, 2006.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Describe the range of conventional and advanced biological treatment processes for the treatment of bulk organics, nutrients and micro pollutants.
CO2	Design the biological reactors based on biokinetics
CO3	Select appropriate processes for specific applications, and have some knowledge of practical design considerations.
CO4	Execute and assess the performance of bioreactors in laboratory scale
CO5	Describe the range of conventional and advanced biological treatment processes for the treatment of bulk organics, nutrients and micro pollutants.

CEHO20 FREE SURFACE FLOW

Course Code	**:**	CEHO20
Course Title	**:**	**Free Surface Flow**
Type of Course	**:**	HO
Corequisites	**:**	CEPC12
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand free surface flow principles, including velocity distribution and specific energy.
CLO2	To analyze and control hydraulic jumps in various geometries using baffle walls and cross jets.
CLO3	To study flow past deflecting boundaries, oblique shock waves, and spatially varied flows.
CLO4	To design and evaluate flows around side weirs, bottom racks, trench weirs, and wastewater gutters.
CLO5	To apply St. Venant's equations for dam breaks, flood routing, and flow analysis.

Course Content

Free surface flows, velocity distribution, resistance relationships, specific energy and specific force, normal and critical depths computations, governing equation and computation of gradually varied flows.

Elements of hydraulic jump, hydraulic jump in variety of situations including contracting and expanding geometries and rise in floor levels, control of hydraulic jump using baffle walls and cross jets.

Flow past deflecting boundaries, oblique shock waves. Spatially Varied Flows,Flows past side weirs, De Marchi equations, design of side weirs, flow past bottom racks, trench weirs and waste water gutters.

Bulking of flow, mechanism of air entrainments, modelling of aerated flows, development

of self-aerated flows, uniform aerated region, aeration over spillway.

St. Venant's equations and their solution using method of characteristics and finite difference schemes; dam break problem, hydraulic flood routing, Sub-critical and supercritical.

References

1.	Chow, V.T., "Open Channel Hydraulics", McGraw Hill.
2.	Choudhary, M.H., "Open-Channel Flows", Prentice-Hall.
3.	Ranga Raju, K.G., "Flow Through Open Channels, Tata McGraw Hill.
4.	Chanson, H., "The Hydraulics of Open Channel Flow: An Introduction", Elsevier.
5.	K. Subramanya, Engineering Hydrology, Tata McGraw Hill, Information on hydraulics and hydrology

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Analyze free surface flows, including velocity, energy, and depth calculations.
CO2	Evaluate hydraulic jumps and control them with baffle walls and jets.
CO3	Model flows around boundaries, side weirs, and wastewater structures.
CO4	Understand flow bulking, air entrainment, and aeration over spillways.
CO5	Apply St. Venant's equations to dam breaks and flood routing.

CEHO21 WAVE HYDRODYNAMICS

Course Code	**:**	CEHO21
Course Title	**:**	**Wave Hydrodynamics**
Type of Course	**:**	HO
Corequisites	**:**	CEPC12
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the basics of wave motion.
CLO2	To study the different aspects of linear wave theory
CLO3	To enhance the knowledge on wave transformation
CLO4	To provide knowledge on various wave theories and wave forces
CLO5	To analyze non-breaking wave using different wave structure Interaction Methods

Course Content

Conservation of mass, moment and Energy; Euler Equation – Bernoullis Equation. Potential and Stream function.

Linear wave theory: Governing Equation, Boundary Conditions and solutions, Dispersion relation, Constancy of wave period.

Wave celerity, water particle velocities, accelerations, displacements and pressures. Approximations for deep and shallow water conditions. Integral properties of waves: Mass

flux, Energy and energy flux, Group speed, Momentum and momentum flux.

Shoaling, bottom friction and damping, refraction, reflection and diffraction. Wave

Breaking: Type of breaking, Surf similarity parameter. Keulegan-Carpenter number, Ursell Parameter, Scattering parameter, Reynolds Number, Currents – Classification and Design criteria

Non breaking wave forces on slender structures – Morison equation; Diffraction theory, source distribution method. Introduction to non-linear wave theories-Strokes, Cnoidal and Solitary wave theory. Mass transport velocity, Introduction to Random and directional waves.

References

1.	Sarpkaya, T. and Isaacson, M., Mechanics of Wave Forces on Offshore Structures, Van Nostrand Reinhold Co., NewYork, 1981
2.	Dean, R.G. and Dalrymple, R.A., Water wave mechanics for Engineers and Scientists, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1994.
3.	Ippen, A.T., Estuary and Coastline Hydrodynamics, McGraw-Hill Book Company, Inc., NewYork, 1978
4.	Shore Protection Manual Volume I and II, Coastal Engineering Research Centre, Dept. of the Army, US Army Corps of Engineers, Washington DC, 1984.
5.	Sorenson, R.M., Basic Coastal Engineering, A Wiley-Interscience Publication, New York, 1978.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Apply fundamental principles to analyze fluid flow problems
CO2	Employ linear wave theory to solve wave equations.
CO3	Understand wave characteristics and its integral properties.
CO4	Evaluate different wave interactions and breaking.
CO5	Analyze non-breaking wave forces using different methods.

CEHO22 ADVANCED REMOTE SENSING TECHNIQUES

Course Code	**:**	CEHO22
Course Title	**:**	**Advanced Remote Sensing Techniques**
Type of Course	**:**	HO
Corequisites	**:**	CEPC13
Contact Hours	**:**	46
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn the advanced concepts of Remote Sensing technology and Geographic Information System and its data types
CLO2	To gain knowledge about the various classifiers and artificial intelligence tools adopted in geospatial techniques

CLO3	To familiarize with the various remote sensing and GIS data set for civil engineering applications
CLO4	To apply various MCDA, metaheuristic algorithm for vulnerability modelling
CLO5	To learn how to use the soft computing techniques with GIS for vulnerability and susceptibility modelling

Course Content

Microwave-SAR, optical Hyperspectral data for geological, geomorphological, and terrain analysis, geological hazard interpretation and analysis, flood and coastal hazard assessment, application of GEE and soft computing tools in remote sensing.

Advance Classifiers and feature extraction methods: Fuzzy, ANN and sub-pixel- based classification methods, Automatic feature extraction methods, Image segmentation and texture analysis of satellite images; Multivariate and Geostatistics

- Random variables and distributions, ANOVA, Statistical Tests, Regression Analysis, Trend surface analysis, correlation and PCA, Regionalized variables, semi variogram, assessment of various interpolation techniques.

Application of DEM and DTM, Sensitivity analysis of various open source DEM, DEM derivatives and its applications, Flood inundation and submergence modelling.

Application of MCDA techniques using Geospatial data for susceptibility and vulnerability modeling, AHP, Fuzzy, TOPSIS, VIKOR, EDAS, ANFIS for Forest fire, flood, Drought, Landslide vulnerability, MSW solid waste dump site location, wind& solar power site suitability analysis.

Application of Geosciences in Civil Engineering, Vulnerability modelling of earthquake, Liquification slope stability, Landslide and Subsidence, Flood and related hazard, Impact over groundwater, soil erosion, drought.

References

1.	Agarwal, C. S., Garg P. K., Remote Sensing in Natural Resources Monitoring and Management, A. H. Wheeler & Co. Ltd., New Delhi.
2.	Gibson, P. J. Introductory Remote Sensing-Principles and Concepts, Taylor and Francis Press
3.	Gibson, P. J. and C.H. Power, Introductory Remote Sensing-Digital Image Processing and Application, Taylor and Francis Press.
4.	Lillesand, T. M. and R.W. Kiefer, remote Sensing and Image Interpretation, Fourth Edition, John Wiley.
5.	Ramkumar, Mu, (2009) Geological Hazards: Causes, Consequences and Methods of Containment, New India Publishing Agency, New Delhi.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Acquire knowledge on the various Understand the satellite data products for various civil engineering applications.
CO2	Get a sound knowledge on the various remote sensing data products for mapping

	and modelling of susceptibility and vulnerability.
CO3	Acquire knowledge about soft computing techniques, advanced GIS and remote sensing tools.
CO4	Execute and evaluate the real-time problems using advanced geospatial techniques.
CO5	Gain knowledge to develop the technical and technological measures for vulnerability and susceptibility modelling.

CEHO23 RIVER HYDRAULICS AND SEDIMENT TRANSPORT

Course Code	**:**	CEHO23
Course Title	**:**	**River Hydraulics And Sediment Transport**
Type of Course	**:**	HO
Corequisites	**:**	CEPC22
Contact Hours	**:**	46
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the behaviour free surface flow conditions under varying depths of flow in open channel
CLO2	To understand the process of the steady, unsteady and Gradually varying flow in rivers and open channels
CLO3	To Illustrate the design methods of cross section of channels for different flow and geometry conditions.
CLO4	To Provide idea on flow computation, velocity distribution in a river or artificial channel with complex geometry, plan form and flow conditions (steady and unsteady).
CLO5	To understand the Sediment generation and transportation behaviours in Rivers and channels.

Course Content

Derivation of the general one-dimensional equations of continuity, momentum and energy used in open channel flow analysis. Steady non-uniform flows, channel transitions and controls, hydraulic jumps surges-Surface profile for gradually varied flow.

Unsteady flow in open channels, method of characteristics, surge formation. Kinematics of waves, flood routing and overhead flow, Dynamics of Gradually varied flow and classification of flow profile, methods of computation, Spatially varying flow and rapidly varying flow.

River Engineering: Classification of Rivers, Causes of Meandering, The Aggrading type of River, Stage-discharge curves for meandering channels Degrading type of River, Cutoffs, river Training, Types of Training Works.

Origin and formation of sediments- properties of sediments, lift force, tractive stress concept on cohesion less and cohesive soils. Velocity of flow of sediments, regimes of flow; Resistance to flow in alluvial streams, resistance relations based on total resistance and division of resistance into grain and form resistance.

velocity distribution in alluvial channel, Scouring, Bed load computation by empirical equations, dimensional considerations and semi-theoretical equations, siltation, Mechanism of suspension, general equations of diffusion.

References

1.	V. T. Chow, Open Channel Hydraulics, McGraw-Hill Publishing Company, New Delhi, 1993.
2.	R. J. Garde, K. G. Ranga Raju, Mechanics of Sediment Transportation and Alluvial Stream Problems, New Age International, 2000.
3.	M. Hanif Chaudhry, Open-Channel Flow, Springer, USA, 2nd edition, 2008.
4.	K. Subramanya, Flow in Open Channel, Tata McGraw, 2009.
5.	Rajesh Srivastava, Flow through open channels, Oxford University Press, 2008.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Know the fundamental of free surface flow and sediment transport in rivers and channels.
CO2	Compute the flow velocity distribution, roughness in a channel with given geometry, plan form and flow conditions.
CO3	Able to understand the characteristic of nonuniform flow and unsteady flow in a Channel.
CO4	Able to solve the problem of propagation of flood wave, flood routing and surges in channels.
CO5	Understand the hydraulics of sediment transport in mobile bed channel.

CEHO24 ADVANCED SOIL MECHANICS

Course Code	**:**	**CEHO24**
Course Title	**:**	**Advanced Soil Mechanics**
Type of Course	:	HO
Prerequisites	:	CEPC16
Contact Hours	:	36
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To Analyze the effects of ion concentration, ionic valency, pH, dielectric constant, and temperature on the double layer distance and soil-water interactions.
CLO2	To Measure soil fabric properties, evaluate factors affecting soil compaction, and use Boussinesq and Westergaard's theories to analyze stress distribution in soils.
CLO3	To Apply Mohr-Coulomb failure criteria to determine shear parameters under different drainage conditions and predict pore water pressures analytically.
CLO4	To Use Terzaghi's unidimensional consolidation theory to estimate soil settlements and analyze creep and stress relaxation using rheological models.
CLO5	To Construct flow nets for confined and unconfined flow using relaxation techniques and conformal mapping, and analyze phreatic surfaces and seepage forces in soils.

Course Content

Origin of soils - Physical and physio-chemical behaviour of soils – diffused double layer theory – computation of double layer distance – effect of ion concentration, ionic valency, pH, dielectric constant, temperature on double layer – stern layer – attractive and repulsive forces in clays – types of soil water – mechanism of soil – water interactions - soil structure. Problems associated with swelling and shrinkage behaviour of soils –Causes, consequences and mechanisms – factors influencing swell – shrink characteristics – swell potential – osmotic swell pressure

Soil fabric and measurement – sensitivity, thixotropy of soils – soil suction – soil compaction – factors affecting soil compaction. Stresses and displacements in soil: soil as elastic body -concept of effective stress - equations of equilibrium in soil mass -principal stresses and strains -problems of plane stresses and strains -stress distribution by Boussinesq, Westergaard's theory – Newmark's chart - influence of anisotropy on stress distribution - applications to geotechnical problems.

Shear resistance: stress - strain relationship in soils -failure criteria –Mohr Coulomb's failure – Stress Path - shear parameters under different drainage conditions - pore pressure in saturated and unsaturated soils -analytical predictions of pore water pressures - stress dilatancy theory – results of plane strain shear tests -factors affecting shear parameters.

Mechanics of consolidation: phenomenon of consolidation -Terzaghi's theory of unidimensional consolidation - methods to determine precompression history – Radial Consolidation - applications to estimate settlements -introduction of creep and stress relaxation by rheological models.

Mechanics of flow through soils: flow through soils -unidimensional - radial and Spherical flow cases -seepage forces quick sand and piping - flow nets of confined and unconfined flow by relaxation techniques - phreatic surfaces by conformal mapping -flow net for anisotropic non- homogeneous soils. Introduction to Unsaturated Soil Mechanics.

References

1.	Mitchell, J.K., Fundamentals of Soil Behaviour, John Wiley, New York, 2005 third edition
2.	Scott R F, "Principles of Soil Mechanics", Addition Wesley Publishing Co. Inc., 1988
3.	Yong, R.N. and Warkentin, B.P., Introduction to Soil Behaviour, Macmillan, Limited, London, 1979
4.	Bowles, J.E, Physical and Geotechnical Properties of Soil, McGraw-Hill Book Company,1985.
5.	Gopal Ranjan and Rao, A.S.R, Basic and Applied Soil Mechanics, Wiley Eastern Limited, third edition 2016
6.	Das, B.M.,Principles of Geotechnical Engg, PWS Publishing Comp, Boston, seventh edition

Course Outcomes (CO)

At the end of the course student will be able

CO1	Understand the physio-chemical behavior of soils, including diffused double layer

	theory, soil-water interactions, and swelling and shrinkage behaviour
CO2	Comprehend soil fabric, compaction, and the concept of effective stress, and apply theories of stress distribution in soil.
CO3	Evaluate shear resistance in soils, including stress-strain relationships, failure criteria, and pore pressure in saturated and unsaturated soils.
CO4	Understand the mechanics of soil consolidation and apply Terzaghi's theory to estimate settlements and determine precompression history.
CO5	Analyze flow through soils, including unidimensional, radial, and spherical flow, and understand the concepts of quicksand, piping, and flow nets.

CEOE25 SOFT COMPUTING TECHNIQUES IN CIVIL ENGINEERING

Course Code	**:**	CEOE25
Course Title	**:**	**Soft Computing Techniques in Civil Engineering**
Type of Course	**:**	HO
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the basics concepts related to soft computing techniques and appreciate the need for soft computing techniques
CLO2	To learn and apply concepts related to genetic algorithms in the context of construction project management
CLO3	To learn and apply concepts related to fuzzy logic and its application in the context of construction project management
CLO4	To learn and apply concepts related to artificial neural networks in the context of construction project management
CLO5	To examine and apply concepts related to hybrid systems in the context of construction project management

Course Content

Introduction to Soft Computing Techniques, Terminologies and Broad Level Classification of Techniques, Need for Soft Computing Techniques

Genetic Algorithms – Goals of optimization – Comparison with traditional methods – Schemata – Terminology in GA – Strings, Structure, Parameter string – Data Structures – Operators – Coding fitness function – Algorithm – Applications

Fuzzy Logic – Concepts of uncertainty and imprecision – Sets – Concepts, properties and operations on Classical sets and Fuzzy Sets - Classical and Fuzzy Relations – Membership Functions – Fuzzy Logic – Fuzzification - Fuzzy Rule-based Systems – Fuzzy propositions – Applications

Artificial Neural Networks – Basics of ANN; Models of a Neuron – Topology: Multi-Layer

Feed Forward Network (MLFFN), Radial Basis Function Network (RBFN), and Recurring Neural Network (RNN) – Learning Processes: Supervised and unsupervised learning. Error-correction learning, Hebbian learning; Single layer perceptrons - Multilayer perceptrons - Least mean square algorithm, Back propagation algorithm Applications

Hybrid Systems – Fuzzy neural systems – Genetic Fuzzy Systems – Genetic Neural Systems

References

1	H.J. Zimmermann (2006) Fuzzy set theory and its applications, 4thEdition, Kluwer Academic Publishers.
2	Suran Goonatilake and Sukhdev Khebbal (1995) Intelligent Hybrid Systems, 1st Edition Wiley.
3	Timothy J. Ross (2016) Fuzzy Logic with Engineering Applications, 4th Edition McGrawHill.
4	Simon Haykin (2008) Neural Networks and Learning Technique, 3rd Edition Prentice Hall.
5	J. M. Zurada (1992) Introduction to Artificial Neural Systems, 1st Edition. Jaico Publishers.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Understand and appreciate the basics concepts related to soft computing techniques and the need for soft computing techniques
CO2	Learn and apply concepts related to genetic algorithms in the context of construction project management
CO3	Comprehend and apply concepts related to fuzzy logic and its application in the context of construction project management
CO4	Assess and apply concepts related to artificial neural networks in the context of construction project management
CO5	Examine and apply concepts related to hybrid systems in the context of construction project management

CEOE26 QUANTITATIVE METHODS IN CONSTRUCTION MANAGEMENT

Course Code	**:**	CEOE26
Course Title	**:**	**Quantitative Methods in Construction Management**
Type of Course	**:**	HO
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	Understand Operations Research in Construction Management
CLO2	Identify and formulate optimization problems

CLO3	Formulate and solve linear programming problems specific to civil engineering applications
CLO4	Solve transportation and assignment problems
CLO5	Implement advanced quantitative methods

Course Content

Introduction - Use of Operations Research in Civil Engineering and Managerial Decision making process. Introduction to Optimization Techniques and their application in Engineering Planning, Design and Construction. Various models; Objective function and constraints, convex and concave functions, regions and sets and concepts of probability and statistics.

Linear programming - Formulation of Linear optimization models, Civil engineering applications. Simplex method, special cases in simplex method, Method of Big M, Two phase method, duality, sensitivity analysis.

Transportation problems - Approximation method, Assignment problems - Hungarian Methods of Solution.

Dynamic programming - Bellman's principle of optimality. Other Techniques - Decision theory, Queuing theory and Games theory - Monte Carlo Simulation

References

1	Hamdy A.Taha, Operations Research, Pearson Education India, 10th Edition, 2016.
2	Ravindran, Engineering Optimization Methods and Applications, John Wiley & Sons, Inc., 9th Edition, 2011.
3	Vohra, N. D., Quantitative Techniques in Management, McGraw Hill Education, 5th Edition, 2017.
4	Wangner, H.M., Principles of Operations Management by, Prentice Hall India Learning Private Limited, 1980.
5	Hira and Gupta, S.Chand, Operation Research, S. Chand Publisher, 2007.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Demonstrate the application of operations research techniques to enhance managerial decision-making in construction projects
CO2	Utilize various optimization techniques in engineering planning, design, and construction contexts
CO3	Formulate and solve linear optimization models
CO4	Apply approximation methods to solve transportation problems in construction projects
CO5	Utilize decision theory, queuing theory, games theory, and Monte Carlo simulation to analyze and solve complex construction management problems

GENERAL INSTITUTE REQUIREMENT (GIR)

CEIR10 INTRODUCTION TO CIVIL ENGINEERING

Course Code	**:**	CEIR15
Course Title	**:**	**Introduction to Civil Engineering**
Type of Course	**:**	GIR
Corequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To Understand fundamental principles of Structural Engineering.
CLO2	To Apply Geotechnical Engineering concepts to solve construction challenges.
CLO3	To Analyze transportation systems and design appropriate pavements.
CLO4	To Design infrastructure for water and wastewater management.
CLO5	To Utilize geomatics techniques for precise surveying and mapping in civil engineering projects.

Course Content

Role of Civil engineers in society, Ethics in Civil Engineering Practice, outstanding accomplishments of the profession, future trends, Types of projects, stages of projects, Specifications and Scope.

State of the art lectures on Structures, Transportation, Water Resources, Environment, Geotechnical and GIS / GPS / RS. Introduction to Engineering geology and seismology.

Properties and uses of construction materials such as stones, bricks, cement, concrete and steel.

Site selection for buildings – components of building foundation – shallow and deep foundations – brick and stone masonry – plastering – lintels, beams and columns – roofs.

References

1	*Sushil Kumar, Building construction, Standard Publishers, 2001*
2	*Rangwala S.C, Building materials, Charotar Publishing House Pvt. Limited, Edition 27, 2009.*
3	*Subinay Gangopadhyay, Engineering Geology, Oxford University Press, 2013*
4	*M. S. Palanichamy, Basic Civil Engineering, Tata Mc Graw Hill, 2000.*
5	*Lecture Notes Prepared by Civil Engineering Department, NIT-T.*

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Apply principles of analysis and design to various structural systems in buildings, bridges, and infrastructure projects.

CO2	Apply principles of analysis and design to various structural systems in buildings, bridges, and infrastructure projects.
CO3	Evaluate transportation systems, design pavements using conventional and new materials, and understand airfield pavement structure.
CO4	Design infrastructure for water and wastewater management in civil engineering projects.
CO5	Utilize surveying methods, maps, aerial photographs, GPS, LiDAR, UAV surveys, and GIS in civil engineering projects effectively.

CEIR11 BASICS OF CIVIL ENGINEERING

Course Code	**:**	CEIR11
Course Title	**:**	**Basics of Civil Engineering**
Type of Course	**:**	GIR
Corequisites	**:**	-
Contact Hours	**:**	
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To Identify and describe the properties and uses of stones, bricks, cement, concrete, and steel in construction projects.
CLO2	To Demonstrate proficiency in constructing foundations, masonry (brick and stone), plastering, and installing lintels, beams, columns, and roofs.
CLO3	To Classify rural and urban roads, evaluate pavement materials, and analyze traffic signs, road markings, and traffic signals.
CLO4	To Learn and apply chain surveying, ranging, and compass survey techniques, using various survey equipment effectively.
CLO5	To Investigate water sources, dams, water supply systems, wastewater treatment methods, and strategies for managing groundwater and preventing sea water intrusion.

Course Content

Properties and uses of construction materials - stones, bricks, cement, concrete and steel.

Site selection for buildings - Component of building - Foundation- Shallow and deep foundations - Brick and stone masonry - Plastering - Lintels, beams and columns - Roofs.

Surveying Importance – Principles – Types – Equipments - Types of Maps – Advanced Surveying Techniques

Transportation - Modes of Transportation - Classification of Roads - Cross sectional Elements - Pavements - Traffic Parameters - Traffic Management System.

Surveying Importance – Principles – Types – Equipment - Types of Maps – Advanced Surveying Techniques
Sources of Water – Characteristics of water -- Water Supply-Quality of Water-Wastewater

Treatment

References

1	Punmia, B.C, Ashok Kumar Jain, Arun Kumar Jain, Basic Civil Engineering, Lakshmi Publishers, 2012.
2	Satheesh Gopi, Basic Civil Engineering, Pearson Publishers, 2009
3	Rangwala, S.C, Building Materials, Charotar Publishing House, Pvt. Limited, Edition 27, 2009.
4	Palanichamy, M.S, Basic Civil Engineering, Tata McGraw Hill, 2000.
5	Lecture notes prepared by Department of Civil Engineering, NITT.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Gain knowledge on site selection, construction materials, components of buildings, roads and water resources
CO2	Appreciate multidisciplinary approach when involved in Civil Related Projects.
CO3	Comprehend the classification of rural and urban roads, pavement materials, and traffic management.
CO4	Demonstrate proficiency in surveying techniques and equipment.
CO5	Understand various sources of water, water supply systems, quality assessment, wastewater treatment, and groundwater management.

CEIR14 PROFESSIONAL ETHICS

Course Code	**:**	CEIR14
Course Title	**:**	**Professional Ethics**
Type of Course	**:**	GIR
Prerequisites	**:**	-
Contact Hours	**:**	36
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To identify the core values that shape the ethical behaviour of an engineer
CLO2	To learn ethical principles pertaining to their engineering society
CLO3	To appreciate the rights of self and others in the context of practicing an engineering field
CLO4	To learn and appreciate the importance of professional ethics from a global management perspective
CLO5	To comprehend and appreciate the role of engineers in technological development from an ethical perspective

Course Content

Human Values - Morals, values and Ethics – Integrity – Work ethic – Service learning –

Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management

Engineering Ethics – Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories

Engineering as social experimentation – Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law

Safety, responsibilities and rights – Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination

Global issues – Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Code of Conduct – Corporate Social Responsibility – Sample Code of Conduct Ethics in Civil Engineering – BIS Standards, IRC, ASCE, ICE, British Standards

References

1	Charles E Harris, Michael S Pritchard and Michael J Rabins. (2000). *Engineering Ethics – Concepts and Cases*, Thompson Learning.
2	Naagarazan, R. S. (2007). *A textbook on professional ethics and human values*. New Age International.
3	Gaur, R. R., Sangal, R., and Bagaria, G. P. (2010). *A Foundation Course in Human Values and Professionals Ethics*. Excel Books India.
4	Robinson, S., Dixon, R., Preece, C. and Moodley, K. (2007). *Engineering, business & professional ethics*. Routledge.
5	John R Boatright. (2003). *Ethics and the Conduct of Business*, Pearson Education

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Understand the core values that shape the ethical behaviour of an engineer
CO2	Apply ethical principles pertaining to their engineering society
CO3	Comprehend and assess the rights of self and others in the context of practicing an engineering field
CO4	Assess and appreciate the importance of professional ethics from a global management perspective
CO5	Perform their role in technological development from an ethical perspective

CEIR16 WINTER INTERNSHIP

Course Code	**:**	CEIR16
Course Title	**:**	**Winter Internship**
Type of Course	**:**	GIR
Prerequisites	**:**	-
Contact Hours	**:**	-
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To provide students with practical exposure to real-world Civil Engineering projects.
CLO2	To develop students' ability to apply theoretical knowledge to solve practical engineering problems.
CLO3	To enhance students' skills in project management, teamwork, and communication in a professional setting.
CLO4	To foster ethical responsibility and professional conduct in Civil Engineering practice.
CLO5	To enable students to reflect on their learning experiences and adapt to evolving engineering challenges.

Course Content

Students shall undergo several weeks of internship in a Industry, Research / Academic institutions as per the Institute Rules and Regulations

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Apply theoretical Civil Engineering knowledge to practical projects and real-world situations.
CO2	Develop and execute project plans in a professional environment.
CO3	Communicate effectively with project teams, clients, and stakeholders through reports and presentations.
CO4	Demonstrate professional ethics, responsibility, and conduct in a Civil Engineering setting.
CO5	Analyze and reflect on internship experiences to identify areas for personal and professional growth.

CEIR16 SUMMER INTERNSHIP

Course Code	**:**	CEIR16
Course Title	**:**	**Summer Internship**
Type of Course	**:**	GIR
Prerequisites	**:**	-
Contact Hours	**:**	-

Course Assessment Methods	**:**	Continuous Assessment

Course Learning Objectives (CLO)

CLO1	To provide students with practical exposure to real-world Civil Engineering projects.
CLO2	To develop students' ability to apply theoretical knowledge to solve practical engineering problems.
CLO3	To enhance students' skills in project management, teamwork, and communication in a professional setting.
CLO4	To foster ethical responsibility and professional conduct in Civil Engineering practice.
CLO5	To enable students to reflect on their learning experiences and adapt to evolving engineering challenges.

Course Content

Students shall undergo several weeks of internship in a Industry, Research / Academic institutions as per the Institute Rules and Regulations

Industry Insights and Emerging Course Outcomes (CO)

At the end of the course student will be able to

CO1	Apply theoretical Civil Engineering knowledge to practical projects and real-world situations.
CO2	Develop and execute project plans in a professional environment.
CO3	Communicate effectively with project teams, clients, and stakeholders through reports and presentations.
CO4	Demonstrate professional ethics, responsibility, and conduct in a Civil Engineering setting.
CO5	Analyze and reflect on internship experiences to identify areas for personal and professional growth.

CEIR19 INDUSTRIAL LECTURE

Course Code	**:**	CEIR19
Course Title	**:**	**Industrial lecture**
Type of Course	**:**	GIR
Prerequisites	**:**	-
Contact Hours	**:**	-
Course Assessment Methods	**:**	Continuous Assessment

Course Learning Objectives (CLO)

CLO1	To expose students to current industry trends and practices in Civil Engineering.
CLO2	To bridge the gap between academic knowledge and industrial applications.
CLO3	To enhance understanding of professional practices, ethics, and challenges in the

	Civil Engineering industry.
CLO4	To develop critical thinking and problem-solving skills through interaction with industry experts.
CLO5	To inspire students for lifelong learning and continuous professional development in Civil Engineering.

Course Content

Industry Insights and Emerging Trends: Lectures on current developments, technologies, and challenges in the Civil Engineering industry.

Case Studies and Professional Practices: Discussions on real-world projects, ethical considerations, and the application of academic knowledge in professional settings.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Understand and discuss current industry trends and practices in Civil Engineering.
CO2	Apply theoretical knowledge to analyze industrial case studies and practices.
CO3	Demonstrate understanding of professional ethics and responsibilities in the Civil Engineering industry.
CO4	Engage with industry professionals to enhance problem-solving and critical thinking skills.
CO5	Reflect on the importance of continuous learning and professional development in Civil Engineering.

CEIR17 PROJECT WORK

Course Code	**:**	CEIR17
Course Title	**:**	**Project Work**
Type of Course	**:**	GIR
Prerequisites	**:**	-
Contact Hours	**:**	-
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To enable students to identify and formulate complex Civil Engineering problems based on comprehensive literature review and research.
CLO2	To guide students in applying engineering principles, modern tools, and techniques to develop and execute a Civil Engineering project.
CLO3	To facilitate students in designing and implementing solutions that consider societal, environmental, and ethical aspects.
CLO4	Encourage effective communication of project outcomes through reports and presentations.
CLO5	To prepare students for lifelong learning and adaptability in the evolving field of Civil Engineering.

Course Content

Students have to conduct and complete a research project on the topic relevant to Civil Engineering.

Departmental project evaluating committee shall perform. The students shall on regular basis report to the supervisor and update the progress / work done, while also consulting and taking the suggestions, comments concerning the progress and future path/tasks of the project.

Upon successful completion of the project, the students shall submit a comprehensive report in the institute / department specified format and also present their work to the examining pannel.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Identify and define a complex Civil Engineering problem through detailed literature review and research.
CO2	Apply Civil Engineering principles and modern tools to develop and execute a project plan.
CO3	Design and implement innovative solutions to address specific Civil Engineering challenges.
CO4	Communicate project outcomes effectively through well-structured reports and presentations.
CO5	Demonstrate teamwork, ethical responsibility, and project management skills in executing the project.

CEIR18 COMPREHENSIVE VIVA VOCE

Course Code	**:**	CEIR18
Course Title	**:**	**Comprehensive Viva Voce**
Type of Course	**:**	GIR
Corequisites	**:**	-
Contact Hours	**:**	-
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

This course is a General Institute Requirement (GIR) to comprehensively assess the student's knowledge in the Civil Engineering discipline. This course doesn't involve any theory/lecture hours but only the exams based on GATE syllabus, as mentioned below.

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Analyze statically determinate and indeterminate structures using structural analysis methods.

CO2	Design concrete and steel structural components based on design codes and standards.
CO3	Evaluate soil properties and design foundation systems for various soil conditions.
CO4	Apply fluid mechanics and hydrology principles to design water resource systems.
CO5	Implement environmental engineering practices for water and wastewater treatment and solid waste management.