

**Revised Curriculum of B.E. Degree Syllabus for Third Year in Civil Engineering (CE)**  
**SEMESTER – V**

SL No	Category	Paper Code	Course Title	Hours Per Week			Credits	Marks
				L	T	P		
1	Professional Core Courses	PCC-CE 501	Surveying-II	2	1	0	3	100
		PCC-CE 551	Surveying Practice-II	0	0	2	1	100
2	Professional Core Courses	PCC-CE 502	Basic Soil Mechanics	2	1	0	3	100
		PCC-CE 552	Soil Mechanics Lab-I	0	0	2	1	100
3	Professional Core Courses	PCC-CE 503	Concrete Technology	2	1	0	3	100
		PCC-CE 553	Concrete Technology Lab-I	0	0	2	1	100
4	Professional Core Courses	PCC-CE 504	Environmental Engineering-II	2	0	0	2	100
		PCC-CE 554	Environmental Engineering Laboratory	0	0	2	1	100
5	Professional Core Courses	PCC-CE 505	Structural Analysis-I	2	1	0	3	100
6	Professional Core Courses	PCC-CE 506	Hydrology and Ground water	2	1	0	3	100
7	Humanities and Social Sciences including Management Courses	HSM-HU 581	Grooming & Personality Development	0	0	2	1	100
<b>Total:</b>							<b>22</b>	<b>1100</b>

**SEMESTER – VI**

SL No	Category	Paper Code	Course Title	Hours Per Week			Credits	Marks
				L	T	P		
1	Professional Core Courses	PCC-CE 601	Transportation Engineering	2	1	0	3	100
		PCC-CE 651	Transportation Engineering Laboratory	0	0	3	1.5	100
2	Professional Core Courses	PCC-CE 602	Planning & Construction Management	2	1	0	3	100
3	Professional Elective Courses	PEC-CE I*	Professional Elective-I	2	1	0	3	100
4	Professional Elective Courses	PEC-CE II*	Professional Elective-II	2	1	0	3	100
5	Professional Elective Courses	PEC-CE III*	Professional Elective-III	2	1	0	3	100
6	Professional Elective Courses	PEC-CE IV*	Professional Elective-IV	3	0	0	3	100
7	Professional Core Courses	PCC-CE 652	Soil Mechanics Lab-II	0	0	3	1.5	100
8	Professional Core Courses	PCC-CE 653	Concrete Technology Lab-II	0	0	2	1	100
9	Professional Core Courses	PCC-CE 681	Design Sessional-I	0	0	2	1	100
10	Humanities and Social Sciences including Management Courses	HSM-HU 681	Group Discussion & Personal Interview	0	0	2	1	100
<b>Total:</b>							<b>24</b>	<b>1100</b>

# Students have to go for compulsory internship after 6<sup>th</sup> semester.

\* Professional Elective Courses (PEC) for 6<sup>th</sup> Semester are referred to appendix-I.

**Revised Curriculum of B.E. Degree Syllabus for Fourth Year in Civil Engineering (CE)**  
**SEMESTER – VII**

SL No	Category	Paper Code	Course Title	Hours Per Week			Credits	Marks
				L	T	P		
1	Professional Core Courses	PCC-CE 701	Design of Steel Structure	2	1	0	3	100
2	Professional Elective Courses	PEC-CE V*	Professional Elective-V	2	1	0	3	100
3	Professional Elective Courses	PEC-CE VI*	Professional Elective-VI	2	1	0	3	100
4	Open Elective Courses	OEC- I **	Open Elective-I	3	0	0	3	100
5	Professional Core Courses	PCC-CE 781	Design Sessional-II	0	0	3	1.5	100
6	Professional Core Courses	PCC-CE 751	Computer Application in Civil Engineering-I	0	0	3	1.5	100
7	Project***	PROJ-INT 791	Internship	0	0	0	2	100
8	Project	PROJ-CE 791	Project-I	0	0	06	3	100
<b>Total:</b>							<b>20</b>	<b>800</b>

\* Professional Elective Courses (PEC) for 7<sup>th</sup> Semester are referred to appendix-II.

\*\* Open Elective Courses (OEC) are referred to appendix-IV.

\*\*\*Marks Evaluation for internship completed during the summer vacation after 6<sup>th</sup> semester.

**SEMESTER – VIII**

SL No	Category	Paper Code	Course Title	Hours Per Week			Credits	Marks
				L	T	P		
1	Professional Elective Courses	PEC-CE VII*	Professional Elective-VII	3	0	0	3	100
2	Professional Elective Courses	PEC-CE VIII*	Professional Elective-VIII	3	0	0	3	100
3	Open Elective Courses	OEC- II**	Open Elective-II	3	0	0	3	100
4	Professional Core Courses	PCC-CE 851	Computer Application in Civil Engineering-II	0	0	2	1	100
5	Project	PROJ-CE 891	Project-II	0	5	0	5	100
6	Project	PROJ-CE 892	Seminar	0	0	4	2	100
<b>Total:</b>							<b>17</b>	<b>600</b>

\* Professional Elective Courses (PEC) for 8<sup>th</sup> Semester are referred to appendix-III.

\*\* Open Elective Courses (OEC) are referred to appendix-IV.

*The Elective Subject code & subject name (for professional elective & open elective courses) will be displayed to the students prior to the Corresponding Semester.*

**BASKET OF ELECTIVE COURSES OF ELECTED TRACKS****Appendix-I****(Elective Subjects for 6<sup>th</sup> Semester)**

<b>SL No</b>	<b>Paper Code</b>	<b>Name of the paper</b>
1	PEC-CE611 (a)	Irrigation Engineering
2	PEC-CE611 (b)	Groundwater
3	PEC-CE611 (c)	Structural Analysis-II
4	PEC-CE611 (d)	Design of Concrete Structures
5	PEC-CE611 (e)	Composite Structure
6	PEC-CE611 (f)	Theory of Plates and Shells
7	PEC-CE611 (g)	Advanced Soil Mechanics and Foundation Engineering
8	PEC-CE611 (h)	Environmental Geo-technology
9	PEC-CE611 (i)	Advance Water & Waste Water Technology
10	PEC-CE611 (j)	Solid & Hazardous Waste Management
11	PEC-CE611 (k)	Remote Sensing and Geographical Information System
12	PEC-CE611 (l)	Public Transportation Systems
13	PEC-CE611 (m)	Transportation Economics
14	PEC-CE611 (n)	Pavement Construction and Management

**Appendix-II****(Elective Subjects for 7<sup>th</sup> Semester)**

1	PEC-CE711 (a)	Advanced Structural Analysis
2	PEC-CE711 (b)	Structural Dynamics & Earthquake Resistance Structure
3	PEC-CE711 (c)	Prefabricated Building & Structure
4	PEC-CE711 (d)	Reliability Analysis of Structures
5	PEC-CE711 (e)	Railway Engineering
6	PEC-CE711 (f)	Airport Planning and Design
7	PEC-CE711 (g)	Geometric Design of Highways
8	PEC-CE711 (h)	Port and Harbour Engineering
9	PEC-CE711 (i)	Hydraulic Structure & Flood Control Engineering.
10	PEC-CE711 (j)	River Engineering
11	PEC-CE711 (k)	Rock Mechanics & Tunnelling
12	PEC-CE711 (l)	Ground Improvement Techniques
13	PEC-CE711 (m)	Environmental Pollution Control Technology
14	PEC-CE711 (n)	Air and Noise Pollution and Control

### **Appendix-III**

#### **(Elective Subjects for 8<sup>th</sup> Semester)**

1	PEC-CE811 (a)	Advanced Foundation Engineering
2	PEC-CE811 (b)	Dynamics of Soil and Foundation
3	PEC-CE811 (c)	Sub-structure Design
4	PEC-CE811 (d)	Traffic Engineering and Management
5	PEC-CE811 (e)	Pavement Design
6	PEC-CE811 (f)	Pavement Materials
7	PEC-CE811 (g)	Urban Transportation System Planning
8	PEC-CE811 (h)	Sustainable Engineering & Technology
9	PEC-CE811 (i)	Prestressed Concrete
10	PEC-CE811 (j)	Advanced Structural Design
11	PEC-CE811 (k)	Bridge Engineering
12	PEC-CE811 (l)	Design of Offshore Structures
13	PEC-CE811 (m)	Water Resource Planning and Management
14	PEC-CE811 (n)	Basics of Computational Hydraulics

## Appendix-IV

### Common Open Elective Courses (OEC)

Sl. No	Paper code	Sem.	Name of the paper
1.	OEC-HU 521(a)	5th	Sanskrit for Technical Knowledge
2.	OEC-PH 521(b)	5th	Material Science
3.	OEC-EC 521(c)	5th	Bio Medical Electronics
4.	OEC-CSE 521(d)	5th	Introduction to Object Oriented Technology & Python
5.	OEC-EI 521(e)	5th	Optical Instrumentation
6.	OEC-HU 621(a)	6th	History of Science & Engineering in India
7.	OEC-HU 621 (b)	6th	Infrastructure Finance
8.	OEC-EC 621(c)	6th	Microprocessors & Its Applications
9.	OEC-EI 621 (d)	6th	Microprocessors & Its Programming
10.	OEC-M 621(e)	6th	Computational Methods
11.	OEC-HU 721(a)	7th	Introduction to Comparative literature
12.	OEC-HU 721(b)	7th	Economic Policies in India
13.	OEC-M 721(c)	7th	Mathematical Formulation & Approximations
14.	OEC-HU 721(d)	7th	Soft Skills & Interpersonal Communication
15.	OEC-EI 721(e)	7th	MEMS
16.	OEC-EC 721(f)	7th	Nano Electronics
17.	OEC-EE 722(a)	7th	Renewable Energy
18.	OEC-ME 722(b)	7th	Modern Manufacturing Practice
19.	OEC-ME 722(c)	7th	Thermal Engineering & Fluid Machinery
20.	OEC-M 821(a)	8th	Advanced Operations Research
21.	OEC-EE 821(b)	8th	Advanced Topics in Power Systems
22.	OEC-HU 821(c)	8th	Quality Control & Management
23.	OEC-HU 821(d)	8th	Cyber Law and Computer Ethics
24.	OEC-EC 821(e)	8th	Satellite Communication
25.	OEC-EE 821(f)	8th	Energy Audit & Management
26.	OEC-HU 822(a)	8th	Digital Marketing
27.	OEC-HU 822(b)	8th	Human Resource Development & Organizational Behavior
28.	OEC-EC 822(c)	8th	Machine Learning
29.	OEC-EI 822(d)	8th	Sensor Technology
30.	OEC-EE 822(e)	8th	Automotive Control & Robotics
31.	OEC-ME 822(f)	8th	Power Plant Engineering

*\* Refer to the OEC booklet for detailed syllabus.*

**(Appendix-V)**  
**Massive Open online Courses (MOOCS)**

The curriculum for bachelor of civil engineering programme comprise of 160 credit in a total of four year duration. A student must need to complete this 160 credit to get his undergraduate degree. Further he will be eligible to get his under graduate degree with honours, if he/she completes an additional 20 credits. These could be acquired through MOOCs. Since the courses on the different platform keep updating, list of the subject provided below is tentative only.

Sl. No.	Course Name	Provider /platform	Institute/ organization	Course Duration	Credit	URL	Pre-requisite
1	Advanced Concrete Technology	NPTEL	IIT Madras	12 weeks	4	<a href="https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ce21/">https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ce21/</a>	Basic course on Construction Materials in UG level. Additional course on Concrete Technology (UG level) is optional
2	Advanced Topics In The Science And Technology Of Concrete	NPTEL	IIT Madras	04 weeks	2	<a href="https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ce17/">https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ce17/</a>	Courses in Concrete Technology, and preferably Advanced Concrete Technology
3	Applied Environmental Microbiology	NPTEL	IIT Roorkee	12 weeks	4	<a href="https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-ce01/">https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-ce01/</a>	NIL
4	Architectural Conservation And Historic Preservation	NPTEL	IIT Kharagpur	08 weeks	3	<a href="https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ce14/">https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ce14/</a>	NIL
5	Characterization Of Construction Materials	NPTEL	IIT Madras	12 weeks	4	<a href="https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ce01/">https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ce01/</a>	Basic Civil Engineering degree
6	Computational Hydraulics	NPTEL	IIT Kharagpur	12 weeks	4	<a href="https://nptel.ac.in/noc/courses/noc17/SEM2/noc17-ce07/">https://nptel.ac.in/noc/courses/noc17/SEM2/noc17-ce07/</a>	Basic course of Hydraulics/Fluid Mechanics
7	Concrete Engineering And Technology	NPTEL	IIT Kanpur	12 weeks	4	<a href="https://nptel.ac.in/noc/courses/noc15/SEM1/noc15-ce01/">https://nptel.ac.in/noc/courses/noc15/SEM1/noc15-ce01/</a>	Basic understanding of concrete - constituents, properties and test methods; design of concrete structures.
8	Design Of Masonry Structures	NPTEL	IIT Madras	12 weeks	4	<a href="https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ce21/">https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ce21/</a>	Student must have completed courses on Strength of Materials, Structural Analysis
9	Design Of Reinforced Concrete Structures	NPTEL	IIT Kharagpur	12 weeks	4	<a href="https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ce22/">https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ce22/</a>	NIL
10	Digital Elevation Models And Applications	NPTEL	IIT Roorkee	04 weeks	2	<a href="https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-ce09/">https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-ce09/</a>	basic knowledge of GIS
11	Digital Image Processing Of Remote Sensing Data	NPTEL	IIT Roorkee	04 weeks	2	<a href="https://nptel.ac.in/noc/courses/noc17/SEM2/noc17-ce26/">https://nptel.ac.in/noc/courses/noc17/SEM2/noc17-ce26/</a>	Current students of engineering students and current post graduate science students

Sl. No.	Course Name	Provider /platform	Institute/ organization	Course Duration	Credit	URL	Pre-requisite
12	Digital Land Surveying And Mapping (DLS & M)	NPTEL	IIT Roorkee	08 weeks	3	<a href="https://nptel.ac.in/courses/105107158/">https://nptel.ac.in/courses/105107158/</a>	Surveying I & II
13	Earth Sciences For Civil Engineering Part - I & II	NPTEL	IIT Kanpur	08 weeks	3	<a href="https://nptel.ac.in/courses/105104152/">https://nptel.ac.in/courses/105104152/</a>	Basic knowledge of geology is recommended
14	Earthquake Geology:A Tool For Seismic Hazard Assessment	NPTEL	IIT Kanpur	12 weeks	4	<a href="https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ce19/">https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ce19/</a>	NIL
15	Electronic Waste Management - Issues And Challenges	NPTEL	IIT Kharagpur	04 weeks	2	<a href="https://nptel.ac.in/courses/105105169/">https://nptel.ac.in/courses/105105169/</a>	Environmental Sciences; Introduction to Environmental Engineering
16	Energy Efficiency, Acoustics And Daylighting In Building	NPTEL	IIT Delhi	12 weeks	4	<a href="https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ce08/">https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ce08/</a>	BE/BSc. Level Physics & Mathematics
17	Engineering Graphics	NPTEL	IIT Kanpur	08 weeks	3	<a href="https://nptel.ac.in/noc/courses/noc16/SEM1/noc16-ce04/">https://nptel.ac.in/noc/courses/noc16/SEM1/noc16-ce04/</a>	NIL
18	Environmental Engineering- Chemical Processes	NPTEL	IIT Roorkee	12 weeks	4	<a href="https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ce29/">https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ce29/</a>	Entry level chemistry course
19	Environmental Geomechanics	NPTEL	IIT Bombay	12 weeks	4	<a href="https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ce03/">https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ce03/</a>	Basics in Geotechnical Engineering
20	Environmental Remediation Of Contaminated Sites	NPTEL	IIT Roorkee	12 weeks	4	<a href="https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ce05/">https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ce05/</a>	Entry level chemistry course, and understanding of chemical, physical and biological processes on Environmental Engineering
21	Fire Protection, Services And Maintenance Management Of Building	NPTEL	IIT Delhi	12 weeks	4	<a href="https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ce30/">https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ce30/</a>	BE/BSc. Level Physics & Mathematics
22	Fluid Inclusion In Mineral Principles, Methodology, Practice And Application	NPTEL	IIT Kharagpur	08 weeks	3	<a href="https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ce36/">https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ce36/</a>	B. Sc./ M. Sc. in Geology
23	Foundation Design	NPTEL	IIT Kanpur	12 weeks	4	<a href="https://nptel.ac.in/courses/105104/105104162/">https://nptel.ac.in/courses/105104/105104162/</a>	Soil Mechanics
24	Foundation Engineering	NPTEL	IIT Kharagpur	12 weeks	4	<a href="https://nptel.ac.in/courses/105105/105105176/">https://nptel.ac.in/courses/105105/105105176/</a>	Soil Mechanics

Sl. No.	Course Name	Provider /platform	Institute/ organization	Course Duration	Credit	URL	Pre-requisite
25	Geo Spatial Analysis In Urban Planning	NPTEL	IIT Kharagpur	04 weeks	2	<a href="https://nptel.ac.in/courses/105/105/105105202/">https://nptel.ac.in/courses/105/105/105105202/</a>	Nil
26	Geoenvironmental Engineering (Environmental Geotechnology); Landfills, Slurry Ponds & Contaminated Sites	NPTEL	IIT Delhi	12 weeks	4	<a href="https://nptel.ac.in/courses/105/102/105102160/">https://nptel.ac.in/courses/105/102/105102160/</a>	Soil Mechanics or Environmental Science and Engineering.
27	Geology And Soil Mechanics	NPTEL	IIT Kanpur	12 weeks	4	<a href="https://nptel.ac.in/courses/105/104/105104147/">https://nptel.ac.in/courses/105/104/105104147/</a>	Mechanics of solids/Strength of materials
28	Geomorphic Processes: Landforms And Landscapes	NPTEL	IIT Kanpur	08 weeks	3	<a href="https://nptel.ac.in/courses/105/104/105104190/">https://nptel.ac.in/courses/105/104/105104190/</a>	Basic course in Earth Sciences
29	Geomorphology	NPTEL	IIT Roorkee	12 weeks	4	<a href="https://nptel.ac.in/courses/105/107/105107200/">https://nptel.ac.in/courses/105/107/105107200/</a>	Engineering Geology (preferable)Engineering Mechanics (Compulsory)
30	Geosynthetics And Reinforced Soil Structures	NPTEL	IIT Madras	12 weeks	3	<a href="https://nptel.ac.in/courses/105/106/105106052/">https://nptel.ac.in/courses/105/106/105106052/</a>	Basic Soil Mechanics and Foundation Engineering/ Geotechnical Engineering
31	Geosynthetics Testing Laboratory	NPTEL	IIT Bombay	04 weeks	2	<a href="https://nptel.ac.in/courses/105/101/105101176/">https://nptel.ac.in/courses/105/101/105101176/</a>	Basic Soil Mechanics and Foundation Engineering/ Geotechnical Engineering
32	Geotechnical Engineering II Foundation Engineering	NPTEL	IIT Kharagpur	12 weeks	4	<a href="https://nptel.ac.in/courses/105/105/105105185/">https://nptel.ac.in/courses/105/105/105105185/</a>	Soil Mechanics/Geotechnical Engineering-I
33	Geotechnical Engineering Laboratory	NPTEL	IIT Bombay	04 weeks	2	<a href="https://nptel.ac.in/courses/105/101/105101160/">https://nptel.ac.in/courses/105/101/105101160/</a>	Basic Soil Mechanics and Foundation Engineering/ Geotechnical Engineering
34	Glass In Buildings: Design And Applications	NPTEL	IIT Madras	12 weeks	4	<a href="https://nptel.ac.in/courses/105/106/105106177/">https://nptel.ac.in/courses/105/106/105106177/</a>	Elective for third Year Civil Engineering
35	Glass Processing Technology	NPTEL	IIT Madras	12 weeks	4	<a href="https://nptel.ac.in/courses/105/106/105106178/">https://nptel.ac.in/courses/105/106/105106178/</a>	None
36	Global Navigation Satellite Systems And Applications	NPTEL	IIT Roorkee	04 weeks	2	<a href="https://nptel.ac.in/courses/105/107/105107194/">https://nptel.ac.in/courses/105/107/105107194/</a>	none
37	GPS Surveying	NPTEL	IIT Roorkee	04 weeks	2	<a href="https://nptel.ac.in/courses/105/107/105107157/">https://nptel.ac.in/courses/105/107/105107157/</a>	Basics of Physics and mathematics upto 12th standard and familiarity with use of computer
38	Higher Surveying	NPTEL	IIT Guwahati	12 weeks	4	<a href="https://nptel.ac.in/courses/105/103/105103176/">https://nptel.ac.in/courses/105/103/105103176/</a>	A course on 'Basic Surveying' is pre-requisite



Sl. No.	Course Name	Provider /platform	Institute/ organization	Course Duration	Credit	URL	Pre-requisite
39	Hydration, Porosity & Strength Of Cementitious Materials	NPTEL	IIT Kanpur	08 weeks	3	<a href="https://nptel.ac.in/courses/105/104/105104157/">https://nptel.ac.in/courses/105/104/105104157/</a>	none
40	Hydraulic Engineering	NPTEL	IIT Kharagpur	12 weeks	4	<a href="https://nptel.ac.in/courses/105/105/105105203/">https://nptel.ac.in/courses/105/105/105105203/</a>	Basic Fluid Mechanics
41	Infrastructure Planning And Management	NPTEL	IIT Madras	12 weeks	4	<a href="https://nptel.ac.in/courses/105/106/105106188/">https://nptel.ac.in/courses/105/106/105106188/</a>	none
42	Integrated Waste Management For A Smart City	NPTEL	IIT Kharagpur	12 weeks	4	<a href="https://nptel.ac.in/courses/105/105/105105160/">https://nptel.ac.in/courses/105/105/105105160/</a>	none
43	Introduction To Accounting And Finance For Civil Engineers	NPTEL	IIT Kanpur	08 weeks	3	<a href="https://nptel.ac.in/courses/105/104/105104178/">https://nptel.ac.in/courses/105/104/105104178/</a>	none
44	Introduction To Civil Engineering Profession	NPTEL	IIT Madras	08 weeks	3	<a href="https://nptel.ac.in/courses/105/106/105106201/">https://nptel.ac.in/courses/105/106/105106201/</a>	High school education
45	Introduction To Geographic Information Systems	NPTEL	IIT Roorkee	04 weeks	2	<a href="https://nptel.ac.in/courses/105/107/105107155/">https://nptel.ac.in/courses/105/107/105107155/</a>	none
46	Introduction To Mineral Processing	NPTEL	IIT Kharagpur	12 weeks	4	<a href="https://nptel.ac.in/courses/105/105/105105171/">https://nptel.ac.in/courses/105/105/105105171/</a>	+2 Science
47	Introduction To Remote Sensing	NPTEL	IIT Roorkee	04 weeks	2	<a href="https://nptel.ac.in/courses/121/107/121107009/">https://nptel.ac.in/courses/121/107/121107009/</a>	none
48	Landscape Architecture And Site Planning - Basic Fundamentals	NPTEL	IIT Kharagpur	08 weeks	3	<a href="https://nptel.ac.in/courses/124/105/124105001/">https://nptel.ac.in/courses/124/105/124105001/</a>	none
49	Life Cycle Assessment	NPTEL	IIT Kharagpur	08 weeks	3	<a href="https://nptel.ac.in/courses/105/105/105105157/">https://nptel.ac.in/courses/105/105/105105157/</a>	none
50	Maintenance And Repair Of Concrete Structures	NPTEL	IIT Madras	12 weeks	4	<a href="https://nptel.ac.in/courses/105/106/105106202/">https://nptel.ac.in/courses/105/106/105106202/</a>	Completed 3rd year of a Bachelor program in civil engineering
51	Mass, Momentum And Energy Balances In Engineering Analysis	NPTEL	IIT Kharagpur	08 weeks	3	<a href="https://nptel.ac.in/courses/105/105/105105186/">https://nptel.ac.in/courses/105/105/105105186/</a>	10+2 Science and Mathematics
52	Matrix Method Of Structural Analysis	NPTEL	IIT Kharagpur	08 weeks	3	<a href="https://nptel.ac.in/courses/105/105/105105180/">https://nptel.ac.in/courses/105/105/105105180/</a>	Solid Mechanics, Structural Analysis 1

Sl. No.	Course Name	Provider /platform	Institute/ organization	Course Duration	Credit	URL	Pre-requisite
53	Mechanical Characterization Of Bituminous Materials	NPTEL	PSG Tech., Coimbatore MBCET	12 weeks	4	<a href="https://nptel.ac.in/courses/105/106/105106203/">https://nptel.ac.in/courses/105/106/105106203/</a>	Building Materials
54	Mechanics Of Materials	NPTEL	IIT Madras	12 weeks	4	<a href="https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ce50/">https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ce50/</a>	Engineering Mechanics, Basic Calculus
55	Mechanics Of Solids	NPTEL	IIT Madras	12 weeks	4	<a href="https://nptel.ac.in/noc/courses/noc17/SEM2/noc17-ce17/">https://nptel.ac.in/noc/courses/noc17/SEM2/noc17-ce17/</a>	Physics/Mathematics
56	Mechanics Of Solids	NPTEL	IIT Kanpur	12 weeks	4	<a href="https://nptel.ac.in/noc/courses/noc15/SEM1/noc15-ce02/">https://nptel.ac.in/noc/courses/noc15/SEM1/noc15-ce02/</a>	Physics/Mathematics
57	Mineral Resources: Geology, Exploration, Economics And Environment	NPTEL	IIT Kharagpur	12 weeks	4	<a href="https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-ce13/">https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-ce13/</a>	Introductory Geology (Physical Geology) Course
58	Modern Construction Materials	NPTEL	IIT Madras	12 weeks	4	<a href="https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ce22/">https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ce22/</a>	Building Materials.
59	Natural Hazards	NPTEL	IIT Kanpur	08 weeks	3	<a href="https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ce07/">https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ce07/</a>	Basic knowledge of Earth Science or Natural Disasters is recommended.
60	Natural Hazards - Part-1	NPTEL	IIT Kanpur	08 weeks	3	<a href="https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ce14/">https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ce14/</a>	Basic knowledge of Earth Science or Natural Disasters is recommended.
61	Photogeology In Terrain Evaluation (Part 1 And 2)	NPTEL	IIT Kanpur	08 weeks	3	<a href="https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ce34/">https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ce34/</a>	Basic knowledge of Earth Science or Physical Geography is recommended.
62	Plastic Waste Management	NPTEL	IIT Kharagpur	08 weeks	3	<a href="https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ce07/">https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ce07/</a>	Basic Environmental Science, Basic Differential Equations, Basic Chemistry
63	Plastic Waste Management	NPTEL	IIT Kharagpur	08 weeks	3	<a href="https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ce13/">https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ce13/</a>	Basic Environmental Science, Basic Differential Equations, Basic Chemistry
64	Principles And Applications Of Building Science	NPTEL	IIT Roorkee	04 weeks	2	<a href="https://nptel.ac.in/noc/courses/noc16/SEM2/noc16-ce11/">https://nptel.ac.in/noc/courses/noc16/SEM2/noc16-ce11/</a>	Building Construction and design
65	Principles Of Construction Management	NPTEL	IIT Kanpur	08 weeks	3	<a href="https://nptel.ac.in/noc/courses/noc17/SEM2/noc17-ce18/">https://nptel.ac.in/noc/courses/noc17/SEM2/noc17-ce18/</a>	Building materials, concrete Technology
66	Probability Methods In Civil Engineering	NPTEL	IIT Kharagpur	12 weeks	4	<a href="https://nptel.ac.in/noc/courses/noc16/SEM1/noc16-ce03/">https://nptel.ac.in/noc/courses/noc16/SEM1/noc16-ce03/</a>	Basic Knowledge of Probability and Statistics
67	Project Planning & Control	NPTEL	IIT Madras	08 weeks	3	<a href="https://nptel.ac.in/noc/courses/noc16/SEM1/noc16-ce02/">https://nptel.ac.in/noc/courses/noc16/SEM1/noc16-ce02/</a>	Basic Mathematics with Probability & Statistics

Sl. No.	Course Name	Provider /platform	Institute/ organization	Course Duration	Credit	URL	Pre-requisite
68	Reinforced Concrete Road Bridges	NPTEL	IIT Kharagpur	04 weeks	2	<a href="https://nptel.ac.in/noc/courses/noc17/SEM2/noc17-ce24/">https://nptel.ac.in/noc/courses/noc17/SEM2/noc17-ce24/</a>	Structural Design and Structural analysis
69	Remote Sensing And Digital Image Processing Of Satellite Data	NPTEL	IIT Roorkee	08 weeks	3	<a href="https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ce34/">https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ce34/</a>	Current students of engineering students and current post graduate science students
70	Remote Sensing And GIS	NPTEL	IIT Guwahati	08 weeks	3	<a href="https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ce41/">https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ce41/</a>	None
71	Remote Sensing Essentials	NPTEL	IIT Roorkee	12 weeks	4	<a href="https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ce29/">https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ce29/</a>	Remote Sensing / Geoinformatics companies, e.g NIIT, ESRI India, Leica Geoinformatics, MapmyIndia etc
72	Soil Structure Interaction	NPTEL	IIT Kharagpur	12 weeks	4	<a href="https://nptel.ac.in/courses/105/105/105105200/">https://nptel.ac.in/courses/105/105/105105200/</a>	Soil Mechanics and Foundation Engineering
73	Steel Quality : Role Of Secondary Refining & Continuous Casting	NPTEL	IIT Madras	12 weeks	4	<a href="https://nptel.ac.in/courses/112/106/112106226/">https://nptel.ac.in/courses/112/106/112106226/</a>	none
74	Structural Dynamics	NPTEL	IIIT Hyderabad	12 weeks	4	<a href="https://nptel.ac.in/courses/105/106/105106151/">https://nptel.ac.in/courses/105/106/105106151/</a>	Basic understanding of structural analysis and knowledge of engineering mathematics.
75	Structural Dynamics For Civil Engineers - SDOF Systems	NPTEL	IIT Kanpur	04 weeks	2	<a href="https://nptel.ac.in/courses/105/104/105104189/">https://nptel.ac.in/courses/105/104/105104189/</a>	Basic programming skills to solve some assignment questions.
76	Structural Geology	NPTEL	IIT Kanpur	12 weeks	4	<a href="https://nptel.ac.in/courses/105/104/105104191/">https://nptel.ac.in/courses/105/104/105104191/</a>	Basic Math/Physics and some knowledge of Geological/Earth Sciences
77	Subsurface Exploration : Importance And Techniques Involved	NPTEL	IIT Guwahati	08 weeks	3	<a href="https://nptel.ac.in/courses/105/103/105103182/">https://nptel.ac.in/courses/105/103/105103182/</a>	Engineering would be minimum qualification to know basic soil mechanics
78	Sustainable Engineering Concepts And Life Cycle Analysis	NPTEL	IIT Kharagpur	08 weeks	3	<a href="https://nptel.ac.in/courses/105/105/105105157/">https://nptel.ac.in/courses/105/105/105105157/</a>	none
79	Sustainable Materials And Green Buildings	NPTEL	IIT Delhi	12 weeks	4	<a href="https://nptel.ac.in/courses/105/102/105102195/">https://nptel.ac.in/courses/105/102/105102195/</a>	BE/BSc. Level Physics & Mathematics
80	Sustainable River Basin Management	NPTEL	IIT Madras	08 weeks	3	<a href="https://nptel.ac.in/courses/105/106/105106145/">https://nptel.ac.in/courses/105/106/105106145/</a>	Working knowledge of: the water cycle, water budget, hydrological parameters and instrumentation.
81	Theory Of Elasticity	NPTEL	IIT Kharagpur	12 weeks	4	<a href="https://nptel.ac.in/courses/105/105/105105177/">https://nptel.ac.in/courses/105/105/105105177/</a>	Solid Mechanics

Sl. No.	Course Name	Provider /platform	Institute/ organization	Course Duration	Credit	URL	Pre-requisite
82	Unsaturated Soil Mechanics	NPTEL	IIT Guwahati	12 weeks	4	<a href="https://nptel.ac.in/courses/105/103/105103177/">https://nptel.ac.in/courses/105/103/105103177/</a>	Knowledge of basic soil mechanics
83	Visual Semiotics For Visual Communication	NPTEL	IIT Kharagpur	04 weeks	2	<a href="https://nptel.ac.in/courses/105/105/105105156/">https://nptel.ac.in/courses/105/105/105105156/</a>	none
84	Wastewater Treatment And Recycling	NPTEL	IIT Kharagpur	12 weeks	4	<a href="https://nptel.ac.in/courses/105/105/105105178/">https://nptel.ac.in/courses/105/105/105105178/</a>	none
85	Water Supply Engineering	NPTEL	IIT Kharagpur	12 weeks	4	<a href="https://nptel.ac.in/courses/105/105/105105201/">https://nptel.ac.in/courses/105/105/105105201/</a>	none
86	Data Science for Engineers	swayam	IIT Madras	8 weeks	3	<a href="https://onlinecourses.nptel.ac.in/noc19_cs60/preview">https://onlinecourses.nptel.ac.in/noc19_cs60/preview</a>	Probability and statistics.
87	Introduction to Programming with MATLAB	Coursera	Vanderbilt University	9 weeks	3	<a href="https://www.coursera.org/learn/matlab">https://www.coursera.org/learn/matlab</a>	Basic knowledge of Programming
88	Probability Theory, Statistics and Exploratory Data Analysis	Coursera	Higher School of Economics	8 weeks	3	<a href="https://www.coursera.org/learn/probability-theory-statistics">https://www.coursera.org/learn/probability-theory-statistics</a>	High school Mathematics
89	Learn to Program: The Fundamentals	Coursera	University of toronto	10 weeks	4	<a href="https://www.coursera.org/learn/learn-to-program">https://www.coursera.org/learn/learn-to-program</a>	None
90	Introduction to Data Science	edX	IBM	6 weeks	2	<a href="https://www.edx.org/course/intro-to-data-science">https://www.edx.org/course/intro-to-data-science</a>	Probability and Statistics
91	Data Science Tools	edX	IBM	6 weeks	2	<a href="https://www.edx.org/course/data-science-tools">https://www.edx.org/course/data-science-tools</a>	None
92	The Data Science Method	edX	IBM	6 weeks	2	<a href="https://www.edx.org/course/data-science-method">https://www.edx.org/course/data-science-method</a>	None
93	Python Basics for Data Science	edX	IBM	6 weeks	2	<a href="https://www.edx.org/course/python-basics-for-data-science">https://www.edx.org/course/python-basics-for-data-science</a>	None
94	Analyzing Data with Python	edX	IBM	6 weeks	2	<a href="https://www.edx.org/course/analyzing-data-with-python">https://www.edx.org/course/analyzing-data-with-python</a>	None
95	Visualizing Data with Python	edX	IBM	6 weeks	2	<a href="https://www.edx.org/course/visualizing-data-with-python">https://www.edx.org/course/visualizing-data-with-python</a>	None
96	Machine Learning with Python: A Practical Introduction	edX	IBM	6 weeks	2	<a href="https://www.edx.org/course/machine-learning-with-python-a-practical-introduct">https://www.edx.org/course/machine-learning-with-python-a-practical-introduct</a>	None

Sl. No.	Course Name	Provider /platform	Institute/ organization	Course Duration	Credit	URL	Pre-requisite
97	IELTS Academic Test Preparation	edX	The University of Queensland	10 weeks	3	<a href="https://www.edx.org/course/ielts-academic-test-preparation">https://www.edx.org/course/ielts-academic-test-preparation</a>	School level English
98	GIS Data Acquisition and Map Design	Coursera	University of toronto	7 weeks	3	<a href="https://www.coursera.org/learn/gis-data-acquisition-map-design">https://www.coursera.org/learn/gis-data-acquisition-map-design</a>	Basic knowledge of GIS
99	Applied Statistics and Econometrics	swayam	IIT Kanpur	12 weeks	4	<a href="https://onlinecourses.nptel.ac.in/noc21_hs39/preview">https://onlinecourses.nptel.ac.in/noc21_hs39/preview</a>	mathematics at +2 level (Class XI-XII)
100	Enhancing Soft Skills and Personality	swayam	IIT Kanpur	8 weeks	3	<a href="https://onlinecourses.nptel.ac.in/noc21_hs02/preview">https://onlinecourses.nptel.ac.in/noc21_hs02/preview</a>	No prerequisite is required
101	Patent Law for Engineers and Scientists	swayam	IIT Madras	12 weeks	4	<a href="https://onlinecourses.nptel.ac.in/noc21_hs15/preview">https://onlinecourses.nptel.ac.in/noc21_hs15/preview</a>	A background degree in Science or Technology is preferable
102	Speaking Effectively	swayam	IIT Kharagpur	8 weeks	3	<a href="https://onlinecourses.nptel.ac.in/noc21_hs05/preview">https://onlinecourses.nptel.ac.in/noc21_hs05/preview</a>	An intermediate course in English Language
103	Soft Skill Development	swayam	IIT Kharagpur	8 weeks	3	<a href="https://onlinecourses.nptel.ac.in/noc21_hs07/preview">https://onlinecourses.nptel.ac.in/noc21_hs07/preview</a>	Basic knowledge in communication and a good understanding of English

**## List is tentative only. Subject can be selected from the platform other than mentioned above with consultation of mentor.**

**Detail Syllabus  
(Semester – V)**

Course code	PCC-CE-501				
Category	Professional Core Courses				
Course title	Surveying-II				
Scheme and Credits	L	T	P	Credits	Semester-V
	2	1	0	3	
Pre-requisites (if any)	Surveying-I (PCC-CE 301)				

### Theory Syllabus:

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
1.	Theodolite surveying: Components of a Theodolite, Adjustments, Horizontal and vertical angle measurements, Trigonometric leveling, problems on height and distances, traverse table, co-ordinates	<b>4L+2T</b>
2.	Tachometer: Definition, Principles of stadia, tangential systems, Details of stadia system. Analytic tachometer, Horizontal and inclined sight with staff vertical and normal for both fixed and movable hair tachometer, Errors in tachometer methods.	<b>3L+1T</b>
3.	Triangulation: Adjustments of station and figure, Leveling adjustment, Method of equal shifts.	<b>2L+1T</b>
4.	Spherical Trigonometry : Spherical excess, Convergence of Meridians	<b>2L+1T</b>
5.	Field Astronomy : Definition of Terms, System of astronomical coordinates, determination of azimuth	<b>2L+1T</b>
6.	Setting out of Curves : Simple curves Definition, Notations Designations, Elements of simple curve, Setting out by linear methods and Rankine's tangential method. Two Theodolite and tachometric method, Introduction to Compound and reverse curves, vertical curve: types Transition curves: lemniscates, cubic spiral, cubic parabola, setting out	<b>6L+3T</b>
7.	Hydrographic surveying:	<b>4L+2T</b>

	Vertical control Datum: tide measurement, Horizontal Control: Shore line surveying, Sounding: Location of sounding and reduction, Three point problems, Nautical sextant and station pointer.	
8	Remote Sensing: Introduction to remote sensing and its application in civil engineering,	2L+1T
9	Photographic Survey: Introduction to terrestrial and aerial photogrammetry, determination of true north	3L+2T
<b>Total</b>		<b>28L+14T</b>
<b>Total week required</b>		<b>14</b>
<b>No. of week reserved</b>		<b>02</b>

**Books: Text and/or Reference:**

1. *Surveying -Vol 2,3 & 4 by B.C.Punmia.*
2. *Plane and Geodetic surveying -Vol 2 by David Clark*
3. *Surveying and leveling- Vol 2 by T .P. Kanetkar and Kulkarni*
4. *Fundamentals of surveying-by S.K.Roy, New Delhi.*
5. *Surveying –Bannister, Raymond and Baker, Pearson Education*
6. *Advanced Higher Survey by B.N.Ghosh*

**Course Outcomes:**

At the end of this course, students will be able to

CO1: Use theodolite in the field.

CO2: Gain knowledge about tacheometry.

CO3: Setting out a curve as its requirements.

CO4: Understand the function of remote sensing.

CO5: Understand the hydrographic surveying & its application.

CO6: Apply Photographs for aerial & terrestrial surveying.

Course code	PCC-CE-551				
Category	Professional Core Courses				
Course title	Surveying Practice-II				
Scheme and Credits	L	T	P	Credits	Semester-V
	0	0	2	1	
Pre-requisites (if any)	Surveying-I (PCC-CE 301), Surveying Practice-I (PCC-CE 351)				



**Laboratory Syllabus:**

<b>Module</b>	<b>Course Content</b>
<b>1</b>	<b>Theodolite surveying:</b> Measurement of horizontal angles, repetition and Reiteration methods, Single plane and double plane method of trigonometric leveling Theodolite traverse adjustments.
<b>2</b>	<b>Tachometric surveying:</b> Tacheometric constants, Measurement of horizontal and vertical distance. Tacheometric traverse and contouring.
<b>3</b>	<b>Curve setting:</b> setting out simple curve by chain and tape, offsets from longchord and tangent, from chord produced, Simple curve by rankine's method, setting out compound and reverse curve, Transition curves, Lemniscate curve.
<b>4</b>	<b>Demonstration:</b> Box – Sextant, Nautical sextant and EDM instruments. Use of Total station.
<b>5</b>	Determination of Azimuth of Sun

**Course Outcomes:**

At the end of this course, students will be able to

CO1: Measure horizontal & vertical distance by using theodolite.

CO2: Calculate horizontal & vertical distance by tacheometry.

CO3: Design simple, compound & reverse curve by chain & tape, offsets from long chord method.

CO4: Gain knowledge about Total station.

Course code	PCC-CE 502				
Category	Professional Core Courses				
Course title	Basic Soil Mechanics				
Scheme and Credits	L	T	P	Credits	Semester-V
	2	1	0	3	
Pre-requisites (if any)	Engineering Mechanics, Fluid Mechanics-I				

**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture/ Tutorial Period</b>
<b>1.</b>	<b>Introduction:</b> Origin and formation of Soil: Types, Typical Indian Soil, Fundamental of Soil Structure.	<b>1L</b>
<b>2.</b>	<b>Soil Phase Relationship:</b> Introduction, Block Diagram, Basic definition, Inter relationship of different parameters, Numerical problems.	<b>3L+1T</b>
<b>3.</b>	<b>Index properties of soil:</b> Introduction, Various Index properties, Atterberg's Limits, Soil Indices, Consistency of soil, Relative Density, Numerical Problems. Practical importance of Index properties.	<b>4L+1T</b>
<b>4.</b>	<b>Identification &amp; Classification of soil:</b> Soil Classification- Particle size classification, Textural classification, Highway Research board (HRB) classification, Unified Soil Classification System (USCS), and IS Classification System, Plasticity Chart, Numerical Problems.	<b>2L+1T</b>
<b>5.</b>	<b>Effective Stress Principles:</b> Effective Stress, Neutral Stress, Critical hydraulic gradient, Quick Sand condition, Numerical Problems.	<b>1L+1T</b>
<b>6.</b>	<b>Permeability:</b> Introduction, Darcy's Law, Coefficient of permeability, Determination of Co-efficient of permeability-Laboratory methods, Field methods, Factors effecting co-efficient of permeability, Permeability of Stratified Deposits, Numerical problems.	<b>3L+1T</b>
<b>7.</b>	<b>Seepage through Soils:</b> Introduction, Laplace's Equation for two dimensional flow, Flow nets - properties, graphical construction method, Determination of phreatic line for Earthen Dams, Applications of flow net. Numerical Problems.	<b>4L+1T</b>
<b>8.</b>	<b>Stress Distribution in Soil:</b> Introductions, Bousinesq's formulation for determination of stress due to Point Loads, Strip and Uniformly Loaded Circular area, Pressure Bulbs, Newmark's charts - construction and use. Westergaad's assumption, Numerical problems.	<b>4L+1T</b>
<b>9.</b>	<b>Compaction of Soil:</b> Principles of Compaction, IS Light and Heavy Compaction test, Field Compaction equipment, CBR Test (Soaked, Un-soaked and Field) as per IS recommendation. Numerical problems.	<b>2L+1T</b>
<b>10.</b>	<b>Compressibility &amp; Consolidation of Soil:</b> Terzaghi's theory of one dimensional Consolidation, Compressibility characteristics of soils, Compression Index, Coefficient of compressibility and Volume change, Coefficient of consolidation, Degree of consolidation, Laboratory consolidation test as per IS Code, Numerical problems.	<b>4L+1T</b>

11.	<b>Shear Strength of Soil:</b> Basic concept of Shear Strength of soil, Mohr-Columb's theory, Stress-strain relationship of clays and sands, Laboratory determination of Soil shear Parameters- Direct Shear test, Tri-axial test, Unconfined Compression test, Vane Shear test as per relevant IS codes. Numerical problems.	<b>4L+1T</b>
	<b>Total</b>	<b>32L+10T</b>
	<b>Total week required</b>	<b>14</b>
	<b>No. of week reserved</b>	<b>02</b>

**Books: Text and/or Reference:**

1. *Principles of Soil Mechanics & Foundation Engineering* by – V.N.S. Murthy (UBS Publishers).
2. *Soil Mechanics & Foundation Engineering* by – B.C.Punmia (Laxmi Publications).
3. *Introduction of Soil Mechanics* by- B.M.Das (Galgotia Publications).
4. *Soil Mechanics* by – T.W.Lambe & R.V.Whitman.
6. *Basic & Applied Soil Mechanics* by- Gopal Ranjan & A.S.R.Rao (Willes EasternLtd.)

**Course Outcomes:**

At the end of this course, students will be able to

- CO1: Solve numerical problems on different basic soil parameters by the interpretation of soil-phase relationship.
- CO2: Identify and classify field soil with the help of various Index properties.
- CO3: Compute seepage pressure in hydraulic structures by the construction flownet.
- CO4: Analyze stress in subsoil due to different type of loading by the application of Boussinesq's equation and Newmark's chart.
- CO5: Identify the compaction and consolidation characteristics of field soil from experimental data.
- CO6: Evaluate the shear parameters of soil by different field and laboratory tests.

Course code	PCC-CE 552				
Category	Professional Core Courses				
Course title	Soil Mechanics Lab-I				
Scheme and Credits	L	T	P	Credits	Semester-V
	0	0	2	1	
Pre-requisites (if any)	Soil Mechanics-I				

## Laboratory Syllabus:

Module	Course Content
1.	Field identification of different type of soil without laboratory testing, determination of natural moisture content.
2.	Determination of specific gravity.
3.	Determination of Insitu density by core cutter method/ sand replacement method.
4.	Grain size distribution of cohesionless soil by sieving. Grain size distribution of fine grained soil by hydrometer analysis.
5.	Determination of Atterberg's limits (Liquid limit, Plastic limit and Shrinkage limit).
6.	Determination of co- efficient of permeability by constant head pemeameter (coarse grained soil). Determination of co- efficient of permeability by variable head parameter (fine grained soil).
7.	Determination of compaction characteristics of soil.
8.	Determination of compressibility characteristics of soil by Oedometer test ( co-efficient of consolidation & compression Index)

### Books: Text and/or Reference:

1. *Soil testing by T.W. Lamb, John Willey.*
2. *Soil Testing for Engineers by Mittal and Shukla, Khanna Publishers.*
3. *Soil Testing by KVS Apparao and VCS Rao, University Science Press.*
4. *Measurement of Engineering properties of soil by E Saibaba Reddy & K. Rama Sastri, New age International publication.*

### Course Outcomes:

At the end of this course, students will be able to

- CO1:** Identify and classify field soil performing laboratory tests for physical parameters and consistency limits of soil.
- CO2:** Estimate co-efficient of permeability of soil.
- CO3:** Illustrate optimum moisture content and maximum dry density by testing soil sample by IS compaction test.
- CO4:** Evaluate consolidation parameters of soil performing Consolidation test in laboratory.

Course code	PCC-CE 503				
Category	Professional Core Courses				
Course title	Concrete Technology				
Scheme and Credits	L	T	P	Credits	Semester-V
	2	1	0	3	
Pre-requisites (if any)	None				

### Theory Syllabus

<b>Sl. No.</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial</b>
<b>1.</b>	<b>Concrete as a Structural Material,</b> <b>Cement</b> – Good Concrete Manufacture of Portland Cement, Chemical Composition of Cement, Hydration of Cement, Heat of Hydration and Strength	<b>4L+1T</b>
<b>2.</b>	<b>Aggregates</b> – Classification, Mechanical and Physical Properties, Deleterious Substances, Alkali-Aggregate Reaction, Sieve Analysis, Grading Curves, Fineness modules, Grading Requirements. Testing of Aggregates – Flakiness, Elongation Tests, Aggregate Crushing Value, Ten Percent Fines Value, Impact Value, Abrasion Value. <b>Quality of Water</b> – Mixing Water, Curing Water, Harmful Contents.	<b>6L+2T</b>
<b>3.</b>	<b>Properties of Fresh Concrete</b> – Workability, Factors Affecting Workability, Slump Test Compacting Factor Test, Kelly Ball Test, Flow Table Test, Segregation, Bleeding, Setting Time, Mixing and Vibration of Concrete, Mixers and Vibrators, curing, Methods, Maturity.	<b>6L+2T</b>
<b>4.</b>	<b>Strength of Concrete</b> – Water/Cement ratio, Gel/Space ratio, Strength in Tension, Compression, Effect of Age on Strength, Relation between Compressive and Tensile Strength, Fatigue Strength, Stress Strain Relation and Modules of Elasticity, Poisson's Ratio, Shrinkage and Creep, Compression Test on Cubes, Cylinders, Non-Destructive Tests.	<b>6L+2T</b>
<b>5.</b>	<b>Admixtures</b> – different types, effects, uses.	<b>4L+1T</b>
<b>6.</b>	<b>Cement Concrete Mix Proportion. by I.S. Code method.</b>	<b>3L+1T</b>
<b>7.</b>	<b>Advance concrete technology:-</b> Light-weight, Polymer and Fiber-reinforced concrete.	<b>3L+1T</b>
	<b>Total</b>	<b>32L+10T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

**Books: Text and/or Reference:**

1. *Concrete Technology* by M.L. Gambhir (Tata McGraw Hill Publishing Co. Ltd.)
2. *Concrete Technology* by M.S. Shetty (S.Chand)
3. *Text book of Concrete Technology* by P.D. Kulkarni (Tata McGraw Hill Publishing Co. Ltd.)
4. *Concrete Technology* by A.R. Santakumar
5. *IS 10262- Concrete Mix Proportioning-Guideline.*

**Course Outcomes:**

On completion of the course students will be able to,

**CO1:** gather the basic knowledge about cement concrete and its ingredients and will also be able to understand the properties of cement and its necessity for checking quality of cement as well as the quality of concrete.

**CO2:** understand the necessity of aggregate for making cement concrete and will also be able to understand the properties of aggregate and its necessity for checking quality of aggregate as well as the quality of concrete.

**CO3:** understand the properties of fresh and strength concrete like workability, factors affecting workability, Segregation, Bleeding, Setting Time, Mixing, Water/Cement ratio, Gel/Space ratio, Strength in Tension, Compression etc.

**CO4:** gather the basic knowledge about admixture and will also be able to perform concrete mix proportion by I.S. Code method.

**CO5:** gather the basic knowledge about advance concrete technology like Light-weight, Polymer and Fiber-reinforced concrete

Course code	PCC-CE 553				
Category	Professional Core Courses				
Course title	Concrete Technology Lab –I				
Scheme and Credits	L	T	P	Credits	Semester-V
	0	0	2	1	
Pre-requisites (if any)					

**Laboratory Syllabus**

<b>1.</b> Tests on cement – specific gravity, fineness, soundness, normal consistency, setting time, compressive strength on cement mortar cubes.
<b>2.</b> Tests on fine aggregate – specific gravity, bulking, sieve analysis, fineness modulus, moisture content, bulk density, voids and deleterious materials.

3. Tests on coarse aggregate - specific gravity, sieve analysis, fineness modulus, bulk density and voids.
4. Tests on bricks and tiles (Roofing and Flooring) - Water absorption, breaking loads.

### Text/Reference Books

1. *IS Codes on testing of cement, fine and coarse aggregates, Bricks and tiles.*
2. *Laboratory manual of concrete testing (Part I) – V.V Sastry and M. L. Gambhir.*

### Course Outcome

On completion of the course students will be able to,

**CO1:** test on cement for checking of its quality and different types of properties.

**CO2:** test the properties of fine aggregate and coarse aggregate like specific gravity, sieve analysis, fineness etc.

**CO3:** test the properties of bricks and tiles.

Course code	PCC-CE 504 (Theory)				
Category	Professional Core Course (PCC)				
Course title	Environmental Engineering-II (Theory)				
Scheme and Credits	L	T	P	Credits	Semester – V
	2	0	0	2	
Pre-requisites (if any)	Environmental Engineering-I (PCC-CE 401)				

### Theory Syllabus

Module	Course Content	Lecture / Tutorial Period
1	<b>Sewage and drainage:</b> Definition of some common terms used in sanitary engineering. Systems of sanitation, systems of sewerages. Types of sewage. Sources of sanitary sewage. Estimating the quantity of sanitary sewage and storm sewage.	3L
2	<b>Design of sewers:</b> Nomograms, partial flow diagrams. Testing of sewer lines. Sewer appurtenances. Pumping of sewage. House drainage.	3L
3	<b>Characteristics of sewage:</b> Physical, Chemical and Biological. Test on sewage; Solids, dissolved oxygen, biochemical oxygen demand, stability and relative stability, chlorides, sulphide, nitrogen. pH value, grease, oil and fat. Biological tests, carbon, nitrogen and sulphur cycles.	4L

4	<b>Treatment of sewage:</b> Primary treatment - screen, grit chamber, detritus tank, skimming tank, plain sedimentation sedimentation with coagulation. Secondary treatment - Filtration, normal rate trickling filters, high rate trickling filters activated sludge process, aeration units, types of activated sludge process, sludge digestion. Functional design of primary and secondary treatment units.	4L
5	<b>Solid waste disposal:</b> Quality and quantity of refuse, Collection and conveyance of solid wastes. Disposal of solid waste by composting, and other methods, Salvaging, grinding and discharging into sewers.	4L
6	<b>Disposal by other methods:</b> Oxidation pond, oxidation ditch, aerated lagoon, septic tank, Imhoff tank, Disposal by dilution, irrigation and farming.	4L
7	<b>Air Pollution:</b> Definition, Classification, effects, Criteria Air Pollutants, Health & other ill effects of air Pollution, standard & Limits. Air quality Index, Plume Dispersion Models, Rudiments of Air pollutant Technology	4L
8	<b>Noise Pollution:</b> Noise Pollution Basics of acoustics, measurement, index and mitigation methods, health effects of noise.	2L
	<b>Total</b>	<b>28L</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

#### Text/Reference Books:

1. Environmental Engineering S.K. Garg -KhannaPub .
2. Water Supply , Waste Disposal &Environmental Pollution Engineering – A . K .Chatterjee – KhannaPub .
3. Water Supply & Waste Water Disposal –G .M .Fair ,J . C .Geyer ,D . A .Okun . –Jhon Wiley &Sons
4. Sanitary Engineering Volume II by Kshirasagar.
5. Manual of treatment - A Government of India Publication.
6. Water Supply and Sanitary Engineering By G.S.Birdi
7. Environmental Engineering by Mcaffee, Eddy

#### Course Outcomes:

On completion of the course students will be able to

- CO1:** Recognize the quality and quantity perspectives of sewage
- CO2:** Analyze the characteristics of water and wastewater
- CO3:** Employ the concept of wastewater treatment.
- CO4:** Design the sewerage system
- CO5:** Design the components of water supply systems
- CO6:** Realize the necessary concepts of Air and Noise pollution



Course code	PCC-CE 554 (Laboratory)				
Category	Professional Core Course (PCC)				
Course title	Environmental Engineering Laboratory (Laboratory)				
Scheme and Credits	L	T	P	Credits	Semester – V
	0	0	2	1	
Pre-requisites (if any)	Environmental Engineering-I (PCC-CE 401)				

#### **Laboratory Syllabus**

<b>Sl. No.</b>	<b>Detailed Description</b>	<b>Practical Period</b>
<b>1</b>	Determination of pH, turbidity of water	<b>3P</b>
<b>2</b>	Determination of Solids – suspended , dissolved , settleable and volatile for water and waste water	<b>3P</b>
<b>3</b>	Determination of dissolve oxygen (DO) in water	<b>2P</b>
<b>4</b>	Determination of BOD, COD, TKN in waste water	<b>3P</b>
<b>5</b>	Determination of Hardness of water.	<b>2P</b>
<b>6</b>	Determination of Chloride and Iron in water	<b>3P</b>
<b>7</b>	Estimation of ammoniacal nitrated (NH <sub>3</sub> N) in water and waste water.	<b>2P</b>
<b>8</b>	Determination of Chlorine demand and available Chlorine in water.	<b>2P</b>
<b>9</b>	Available chlorine in bleaching powder, Residual chlorine in water & Chlorine demand.	<b>3P</b>
<b>10</b>	MPN test in water	<b>2P</b>
<b>11</b>	Determination of Acidity and alkalinity in water.	<b>3P</b>
<b>Total</b>		<b>28 P</b>
<b>No. of Weeks Required</b>		<b>14</b>
<b>No. of Weeks in Hand</b>		<b>2</b>

#### **Text/Reference Books**

1. Relevant IS code
2. Standard methods for the examination of water and wastewater. (2012). 21st Edition, Washington: APHA.
3. Sawyer, C. N., McCarty, P. L., and Perkin, G.F., Chemistry for Environmental Engineering and Science, 5th edition McGraw-Hill Inc., 2002
4. B. Kotaiah and Dr. N. Kumara Swamy, Environmental Engineering Laboratory Manual, Charotar Publishing House Pvt. Ltd., 1st Ed., 2007.

**Course Outcomes:**

On completion of the course students will be able to

**CO1:** Determine physical, chemical and biological characteristics of water and wastewater and their measurements.

**CO2:** To compare the result with public health requirements and standards.

**CO3:** Determine the Chlorine demand in water.

**CO4:** Review the quality of water and wastewater.

Course code	PCC-CE505				
Category	Professional Core Course (PCC)				
Course title	Structural Analysis-I				
Scheme and Credits	L	T	P	Credits	Semester – V
	2	1	0	3	
Pre-requisites (if any)	Structural Mechanics (ESC-CE 401)				

**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	<b>Determinate plane trusses:</b> Analysis by method of joints, method of section	<b>2L+1T</b>
<b>2</b>	<b>Analysis of determinate portal frames</b>	<b>2L+1T</b>
<b>3</b>	<b>Deflection of beams by area moment method</b>	<b>4L+2T</b>
<b>4</b>	<b>Strain energy:</b> Due to axial load, bending and shear, Torsion; principle of virtual work, Betti's law, Maxwell's theorem of reciprocal deflection, Castiglino's theorems, theorem of minimum potential energy , Unit-Load method, Use of energy principles for deflection analysis of determinate beams, trusses and simple portal frames.	<b>8L+3T</b>
<b>5</b>	<b>Redundant structures:</b> Concepts of statical and kinematic indeterminacy of beams, trusses and portal frames; Application of second theorem of Castigliano and method of consistent deformation for analysis of propped cantilever, fixed beams and continuous beams (maximum two degree of indeterminacy) for simple loading cases.	<b>6L+4T</b>
<b>6</b>	<b>Influence line diagrams:</b> Statically determinate beams and trusses under series of concentrated and uniformly distributed rolling loads	<b>3L+2T</b>

7	<b>Theorem of three moments:</b> Analysis of continuous beam with simply supported, fixed, over hanging ends span.	3L+1T
	<b>Total</b>	<b>28L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of Weeks in Reserve</b>	<b>2</b>

**Text/Reference Books:**

1. Basic structural Analysis by C.S. Reddy
2. Statically indeterminate structures by C.K.Wang
3. Elementary structural analysis by Norris and Wilber
4. Structures – Schodek, Pearson Education
5. Analysis of Structures – Vol.I& Vol. II by Vazirani&Ratwani
6. Elements of Structural Mechanics by N.C.Sinha&S.K.SenGupta [S.Chand Pub]
7. Analysis of Structures by A.K.Jain
8. Analysis of Structures by Dayaratnam
9. Basic Structural Analysis by Gaylord

**Course Outcomes:**

On completion of the course students will be able to

**CO1:** Calculate the internal forces of truss structures.

**CO2:** Analyze frame structures and also can draw the bending moment & shear force diagram of such structures.

**CO3:** Employ the concept of strain energy theorem and its application.

**CO4:** Draw the influence line diagram of determinate structures (beam and truss).

**CO5:** Determine the deflection and rotation of determinate and indeterminate structures.

**CO6:** Employ the concept of indeterminacy of structures.

Course code	PCC-CE-506				
Category	Professional Core Courses				
Course title	Hydrology & Ground Water				
Scheme and Credits	L	T	P	Credits	Semester-V
	2	1	0	3	
Pre-requisites (if any)	Fluid Mechanics-II (ESC-CE-402)				

**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
1.	Hydrological Cycle, Water Budget Equation, World Water Balance, Significance of Hydrologic Study	<b>2L+1T</b>
2.	<b>Catchment:</b> Definition & Descriptions, Various Types of Catchment, Factors Characterizing a Catchment, Delineation of Catchment Boundary.	<b>2L+1T</b>
3.	<b>Measurement of Precipitation:</b> Precipitation, Description and Functioning of Various Types of Rain gauges, Rain gauge Network- Codal Provisions, Optimum Number of Raingauge Stations.	<b>2L+1T</b>
4.	<b>Processing of Rainfall Data:</b> Normal Rainfall, Estimation of Missing Rainfall Data, Test for Consistency of Record; Mass Curve of Rainfall, Hyetograph, Point Rainfall; Mean Precipitation over an Area– Arithmetic Mean, Thiessen Polygon and Isohyetal Method.	<b>3L+2T</b>
5.	<b>Losses from Precipitation:</b> Evaporation – Evaporation Process, Factors affecting Evaporation, Measurement of Evaporation– Description and Functioning of Pan Evaporimeter, Pan Coefficient, Evapotranspiration: AET, PET, Measurement of ET, Estimation of ET–Blaney Criddle Formulae; Infiltration– Process, Factors Affecting Infiltration, Infiltration Rate and Infiltration Capacity, Measurement of Infiltration, Infiltration Equations, Infiltration Indices.	<b>4L+2T</b>
6.	<b>Streamflow Measurement:</b> Importance, Direct and Indirect Methods, Measurement of Stage– Various Gauges and Recorders, Measurement of Velocity– Current Meters, their Functioning and Calibration; Velocity Distribution, Floats; Streamflow Computation– Area-Velocity Method, Moving Boat Method, Dilution Technique, Electromagnetic Method, Ultrasonic Method; Indirect Methods– Flow Measuring Structures, Slope Area Method; StageDischarge Relation, Permanent Control, Stage for Zero Discharge, Shifting Control– Backwater Effect, Unsteady Flow Effect, Extension of the Rating Curve.	<b>5L+2T</b>
7.	<b>Runoff:</b> Description of the Process, Components of Runoff, Factors Affecting Runoff, Characteristics of Streams, Rainfall Runoff Relationships. Hydrographs: Types, Base Flow Separation, Effective Rainfall.	<b>2L+1T</b>

8	<b>Unit Hydrograph</b> – Definition, Assumptions, Applications– Derivation of Unit Hydrograph, Distribution Graph, Unit Hydrograph of Different Durations– Method of Superposition and S-Curve.	<b>3L+2T</b>
9	<b>Ground water hydrology:</b> Aquifers – Definition, Darcy’s Law, Estimation of Parameters, Flow through water bodies, Water Divide, Basic Laplace Equation, Steady State, Confined & Unconfined equation with recharge, Flood Definition, Effects, Design Flood & Estimation and construction of wells and tube wells	<b>5L+2T</b>
<b>Total</b>		<b>28L+14T</b>
<b>Total week required</b>		<b>14</b>
<b>No. of week reserved</b>		<b>02</b>

**Books: Text and/or Reference:**

*Engineering Hydrology by K. Subramanya, McGraw Hill Education (India) Private Limited, New Delhi, 2013.*

*Hydrology and Flood Control Engineering by S.K.Garg, Khanna publishers*

*Irrigation Engineering and Hydraulic Structures by S.K.Garg, Khanna publishers*

*Introduction to Hydrology by Viessman, Pearson Education*

*Ground Water Hydrology by D.K.Todd*

**Course Outcomes:**

At the end of this course, students will be able to

1. Measure catchment area & rainfall data for a particular river.
2. Gain knowledge about losses from precipitation.
3. Calculate stream flow parameters with different techniques.
4. Gain knowledge on runoff & unit hydrograph.
5. Learn about ground water hydrology.

<b>Course Code</b>	<b>HSM-HU 581 (For Laboratory)</b>					
<b>Category</b>	<b>Humanities and Social Sciences including Management Courses</b>					
<b>Course Title</b>	<b>Grooming &amp; Personality Development</b>					
<b>Scheme and credits</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Semester—V</b>	
	<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>		
<b>Pre-requisites (if any )</b>	<b>Basic knowledge of speaking and writing in English</b>					

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
1.	<b>Self-Development Skills:</b> Introduction to personality; Self-Esteem and Self-Confidence; problem solving; Stress Management; Goal-Setting.	<b>5P</b>
2.	<b>Public Speaking:</b> Importance;Types,Mechanics;Pillars of Public Speaking; Overcoming fear of Public Speaking.	<b>5P</b>
3.	<b>Oral presentation and professional speaking:</b> Basics of English pronunciation public preparing for a speech.; Elements of effective presentations, Body language and use of voice during presentation; connecting with the audience during presentation; projecting a positive image while speaking; planning and preparing a model presentation; Organizing the presentation to suit the audience and content.	<b>6P</b>
4.	<b>Career Oriental Communication:</b> Design and Style applying for a job: Language and format of job application;Resume& bio-data.	<b>5P</b>
5.	<b>Job Interview:</b> Purpose and process, language and style to be used, types of interview question and how to answer them.	<b>7P</b>
	<b>Total</b>	<b>28P</b>
	<b>Total week required</b>	<b>14</b>
	<b>No. of week reserved</b>	<b>02</b>

#### **Text Books:**

1. Development and Soft Skills.Barun K. Mitra, Oxford University Press, New Delhi: 2016.
2. Personality Development: Rajiv K. Mishra, Transform Yourself. Rupa Publications, 2012.
3. Personality Development,Elizabeth B. Hurlock, McGraw Hill Education, 2017.

#### **Reference Books:**

1. Personality Development and Career Management. M. Onkar S. Chand Publication.
2. Managing Soft Skills for Personality Development.Ed.by B. N. Ghosh. McGraw Hill, India: 2012.

**Course outcomes:**

On completion of the course students will be able to:

**CO1:** Groom themselves through the knowledge of personality development attributes –self confidence, problem solving and stress management skills etc.

**CO2:** Deliver confidently an organized, refined, professional and credible speech for better suit the audience.

**CO3:** Acquire the basic concepts of English pronunciation and elements of effective presentations, body language and use of voice during presentation.

**CO4:** Connect with the audience during presentation and exhibit the art of projecting a positive image while speaking and preparing a model presentation.

**CO5:** Learn the effective language for writing job application, resume and bio-data.

**CO6:** Familiar with common interview questions and the techniques to answer them.

**Detail Syllabus  
(Semester – VI)**



Course code	PCC-CE601				
Category	Professional Core Courses				
Course title	Transportation Engineering				
Scheme and Credits	L	T	P	Credits	Semester-VI
	2	1	0	3	
Pre-requisites (if any)	Nil				

### Theory Syllabus:

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	<p><b>Introduction to transportation Engineering:</b> Definition and objectives of transportation Engineering, role of transportation in society, Different modes of transportation, Scope of highway engineering, Historical Development of road Construction; Jayakar Committee Report; Central road fund, Indian Road Congress, central road Research Institute, Moto vehicle act, First twenty year road Plan, second Twenty Year Road Plan, Highway Research Board, third Twenty year road Plan, NHDP, PMGSY, Classification of road, Classification of Highways, Road Pattern, saturation system.</p> <p>Highway financing ('pay as you go method and Credit Points financing method) and highway economics (quantifiable and non-quantifiable, benefits to highway users, cost of vehicle operation, annual cost method, and benefit-cost ratio method)</p> <p><b>Highway Alignment:</b> Requirements; factors controlling alignment; engineering surveys for highway alignment and location.</p>	<b>2L+1T</b>
<b>2</b>	<p><b>Highway Geometric Design:</b> Cross-sectional elements; design speed, passing and non-passing sight distances; PIEV theory, requirements and design principles of horizontal alignment including radius of curvature, super elevation, extra-widening, design of transition curves, curve resistance, set back distance.</p> <p><b>Vertical Curve:</b> Grade compensation, Types, Design of summit and valley curve.</p>	<b>6L+3T</b>
<b>3</b>	<p><b>Highway materials:</b> Significance of subgrade soil, CBR test, Desirable properties and Test of Road aggregate; Bituminous Materials, Bitumen, tar, emulsion, types of bitumen, Test on Bitumen, marshal Method of bituminous mix Design, Moorum,</p>	<b>4L+2T</b>

	Water bound Macadam (WBM), Wet Mix macadam (WMM), bituminous and concrete roads.	
4	<b>Pavement design:</b> Evaluation of soil subgrade, sub-base, base and wearing courses; design factors for pavement thickness (including design wheel load and ESWL, strength of pavement materials and plate load tests, and effect of climatic variations) Group Index and CBR, IRC method of flexible pavement design; Westergaard's analysis of wheel load stresses in rigid pavements; frictional stresses and warping stresses; IRC recommendations for design of rigid pavements; design of expansion and contraction joints. Benkelman Beam Test. Failure of flexible and rigid pavements.	6L+3T
5	<b>Pavement Construction Technique:</b> Types of pavement; construction of earth roads, gravel roads, WBM, bitumen and cement concrete roads; joints in cement concrete pavements.	4L+1T
6	<b>Traffic Engineering:</b> Traffic characteristics, theory of traffic flow, Traffic engineering studies, Intersection design, traffic sign and signal design, highway capacity	6L+4T
	<b>Total</b>	28L+14T
	<b>No. of Weeks Required</b>	14
	<b>No. of weeks in hand</b>	2

**Text/Reference Books:**

1. *Highway Engineering*, C.E.G.Justo and S.K.Khanna, Nem Chand and Brother Publisher.
2. *Textbook of Highway Engineering*, R Srinivasa Kumar (University Press)
3. *Principles, Practice and Design of Highway Engineering*, Dr. S. K. Sharma, S Chand Publisher.
4. *Traffic Engineering & Transportation Planning*, L. R. Kadyali, Khanna Publishers
5. *Principles of Transportation Engineering*: P. Chakraborty & A. Das (PHI)
6. *Transportation Engineering: An Introduction*, C.J Khisty & B.K Lall, Publisher: Pearson
7. *Pavement Analysis and Design* by Yang H. Huang, Pearson Education Publication
8. *IRC: 37-2018 Guidelines for the Design of Flexible Pavements*, The Indian Roads Congress, New Delhi, India, 2012.
9. *IRC: 58-2015 Guidelines for the Design of Plain Jointed Rigid Pavements for Highways*, The Indian Roads Congress, New Delhi, India, 2011.
10. *I.S Specifications on Concrete, Aggregate & Bitumen*, Relevant latest IRC Codes.

**Course Outcomes:**

At the end of this course, students will be able to

**CO1:** to gather knowledge about phase wise development of Indian highway network.

**CO2:** To align highway of a new road project.

**CO3:** design geometric element such as sight distance superelevation, vertical curve, etc. of highway.

**CO4:** To design flexible pavement of a new road project.

**CO5:** To design rigid pavement of roadway.

**CO6:** to do construction of a new road project as well rehabilitation of existing one.

**CO7:** to do traffic study and analysis on a roadway.

Course code	PCC-CE651				
Category	Professional Core Courses				
Course title	Transportation Engineering Laboratories				
Scheme and Credits	L	T	P	Credits	Semester-VI
	0	0	3	1.5	
Pre-requisites (if any)	Nil				

**Syllabus Content**

<b>1. Tests on highway materials</b> – Aggregates- Impact value, Los-Angeles Abrasion value, water absorption, Aggregate Shape test (Elongation & Flakiness Index).
<b>2. Bitumen &amp; Bituminous Materials</b> – Specific gravity, penetration value, softening point, loss on ignition, Flash & Fire point test, Ductility Test, Water Content, Float Test Viscosity Test, Stripping value test,
<b>3. Marshal Stability Test.</b>
<b>4. Benkelman Beam Test.</b>

**Reference Books:**

1. *BIS codes on Aggregates & Bituminous Materials*
2. *Highway material testing ( Laboratory Manual)*
3. *Relevant I.R.C. codes.*

**Course Outcomes:**

At the end of this course, students will be able to

**CO1:** perform test on aggregates to find suitability of it for pavement design and construction.

**CO2:** perform test on bitumen to find suitability of it for pavement design and construction.

**CO3:** design bituminous mix by Marshal method.

**CO4:** perform Benkelman beam test for overlay design.

Course code	PCC-CE 602				
Category	Professional Core Courses				
Course title	Planning & Construction Management				
Scheme and Credits	L	T	P	Credits	Semester-VI
	2	1	0	3	
Pre-requisites (if any)	Nil				

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	<p><b>Planning:</b> General consideration, Definition of aspect, prospect, roominess, grouping, circulation privacy, occlusion</p> <p><b>Regulation and Bye laws :</b> Bye Laws in respect of side space, Back and front space, Covered areas, height of building etc., Lavatory blocks , ventilation, Requirements for stairs, lifts in public assembly building, offices</p> <p><b>Fire Protection:</b> Fire fighting arrangements in public assembly buildings, planning , offices, auditorium</p>	<b>8L</b>
<b>2</b>	<p><b>Construction plants &amp; Equipment:</b> Plants &amp; equipment for earth moving, road constructions, excavators, dozers, scrapers, spreaders, rollers, their uses. Plants &amp; Equipment for concrete construction: Batching plants, Ready Mix Concrete, concrete mixers, Vibrators etc., quality control</p>	<b>6L+2T</b>
<b>3</b>	<p><b>Planning &amp; Scheduling of constructions Projects:</b> Planning by CPM &amp; PERT, Preparation of network, Determination of slacks or floats. Criticalactivities. Critical path, project duration .expected mean time, probability of completion of project,Estimation of critical path, problems. Cost Optimization Through CPM Technique and Resource allocation.</p>	<b>8L+6T</b>
<b>4</b>	<p><b>Management:</b> Professional practice, Definition, Rights and responsibilities of owner, engineer, Contractors, types of contract, NIT, NIQ, E-Tendering, Technical Bid, Condition of Contract, Additional Terms and Condition, Earnest money, Security money, Termination of contract.</p>	<b>8L+4T</b>

	<b>Departmental Procedures:</b> Administration, Technical and financial sanction, operation of PWD, Tenders and its notification, Acceptance of tenders, Arbitration	
	<b>Total</b>	<b>30L+12T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

**## Module:1 is as per National Building Code**

**Text/Reference Books:**

1. Construction Planning, Equipments and methods by R.L. Puerifoy, McGraw Hill.
2. Management in Construction Industry by P.P. Dharwadkar , Oxford and IBH Publishing company , New Delhi.
3. Construction Management, Critical path Methods in Construction by J.O. Brien, Wiley Enterprise.
4. PERT and CPM by L.S. Srinath.
5. Project planning and control with PERT and CPM; Construction equipment and its management by B.C. Punmia and K.K. Khandelwal , S.C. Sharma.
6. National Building code, BIS.

**Course Outcomes:**

At the end of this course, students will be able to

**CO1:** manage all the planning and construction related activities as project manager.

**CO2:** plan all the scheduled activities in a construction project

**CO3:** understand departmental procedure of tendering and contract documentation.

**CO4:** understand safe construction practices

**CO5:** understand use of construction equipment in construction related activities.

Course code	PCC-CE 652				
Category	Professional Core Courses				
Course title	Soil Mechanics Lab-II				
Scheme and Credits	L	T	P	Credits	Semester-VI
	0	0	3	1.5	
Pre-requisites (if any)	Soil Mechanics-I				

**Laboratory Syllabus:**

Module	Course Content
1.	Compute CBR value required for pavement design by testing soil sample using CBR test apparatus.
2.	Determination of swelling index of soil by Free swell test.
3.	Determination of unconfined compressive strength of soil.
4.	Determination of shear parameter of soil by Direct shear test.
5.	Determination of undrained shear strength of soil by Vane shear test.
6.	Determination of shear parameter of soil by Triaxial test.
7.	Standard Penetration Test.

**Books: Text and/or Reference:**

1. *Soil testing by T.W. Lamb, John Willey.*
2. *Soil Testing for Engineers by Mittal and Shukla, Khanna Publishers.*
3. *Soil Testing by KVS Apparao and VCS Rao, University Science Press.*
4. *Measurement of Engineering properties of soil by E Saibaba Reddy & K. Rama Sastri, New age International publication.*

**Course Outcomes:**

At the end of this course, students will be able to

**CO1:** Design pavement thickness from CBR value by testing soil sample using CBR test apparatus.

**CO2:** Estimate swelling index of soil by Free swell test.

**CO3:** Examine undrained shear strength by Vane shear test and unconfined compressive strength of soil.

**CO4:** Evaluate shear parameters of soil by Direct shear test, Tri-axial test in laboratory.

Course code	PCC-CE 653				
Category	Professional Core Courses				
Course title	Concrete Technology Lab -II				
Scheme and Credits	L	T	P	Credits	Semester-VI
	0	0	2	1	
Pre-requisites (if any)	Concrete Technology Lab -I				

**Laboratory Syllabus**

1. Fresh Concrete Workability Test : Slump, Vee-Bee, Compaction Factor Test
2. Hardened Concrete : Compressive Strength, Split Tensile Strength
3. Non Destructive Test of Concrete

4. Tests on Reinforcement Bars
5. Concrete Mix Proportion.

### Text/Reference Books

*IS 10262- Concrete Mix Proportioning-Guideline.*

*Laboratory manual of concrete testing (Part I) – V.V Sastry and M. L. Gambhir*

### Course Outcomes:

On completion of the course students will be able to,

**CO1:** gather the basic knowledge of concrete mix design according to IS 10262, 2009 and can prepare the fresh concrete for different grade (M25) by using concrete mixture machine.

**CO2:** test the properties of fresh concrete, like workability test by Slump test, Compacting factor test etc.

**CO3:** test the properties of hardened concrete, like Compressive test, Split tensile test.

**CO4:** perform Non Destructive Test of existing concrete structure and Test on reinforcement bars.

Course code	PCC-CE 681				
Category	Professional Core Courses				
Course title	Design Sessional-I (R.C.C. Structure)				
Scheme and Credits	L	T	P	Credits	Semester-VI
	0	0	2	1	
Pre-requisites (if any)	Design of Concrete Structure				

### Laboratory Syllabus:

1. General considerations, design principle of R.C.C. sections. Limit state method of design Loads and stresses to be considered in the design as per I.S. code provision.
2. Design & detailing of: i) simply supported R.C.C Beam, ii) Continuous T- Beam.
3. Design & detailing of: i) simply supported one way slab, ii) One way Continuous slab.
4. Design of different units – slab, beam column, roofing and staircase from floor plan of a multistoried frame building – two way action of floor slab.

### Reference Books:

1. *Relevant IS code. (IS 456, 2000)*
2. *SP 16, 2000 and SP 34, 1987*
3. *Reinforced concrete Design by Mallick& Gupta*
4. *Reinforced concrete Limit state design by Ashok K. Jain*
5. *Limit State Design of Reinforced Concrete by P.C. Varghese*

**Course Outcomes:**

On completion of the course students will be able to,

**CO1:** gather the basic knowledge of locating column and beam on a RC building plan for reinforce concrete design purpose and will also able to understand about loads and stresses to be considered in the design as per I.S. code provision.

**CO2:** Analyses the R.C. frame for the present plan under the different load combination as per I.S. code provision.

**CO3:** Design & detailing of R.C.C frame beam and continuous T- Beam used in the existing plan as per I.S. code provision.

**CO4:** Design and detailing of one-way, two-way slab and continuous slab panels as per IS code provisions for the existing plan.

**CO5:** Design and detailing of column and isolated footing subjected to axial compressive force, combine bending (single axial bending and by axial bending) and direct stress for the existing plan.

**CO6:** Design and detailing of reinforced concrete doglegged staircase used in the present plan under its self-weight and imposed lode.

Course Code	HSM-HU 681 (For Laboratory)				
Category	Humanities and Social Sciences including Management Courses				
Course Title	Group Discussion & Personal Interview				
Scheme and credits	L	T	P	Credits	Semester—VI
	0	0	2	1	
Pre-requisites (if any)	Basic knowledge of oral & technical communication				

**Detail Syllabus**

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture/Tutorial Period</b>
1.	<b>Advanced Techniques in Technical Communication:</b> using e-mail for business communication; standard e-mail practices; language in e-mail, using internet for collecting information; referencing while using internet materials for project reports; writing for media.	5P
2.	<b>Presentation:</b> Techniques of effective presentations by using various audiovisual aids	5P



3.	<b>Interview:</b> methods and Etiquettes; practice of mock interview; interview through telephone/ video-conferencing	8P
4	<b>Group Discussion:</b> Model group discussion through the choice of appropriate programmers.	7P
5.	Interaction with experts.	3P
<b>Total</b>		<b>28P</b>
<b>Total week required</b>		<b>14</b>
<b>No. of week reserved</b>		<b>02</b>

#### **Text Books:**

1. How to Prepare for Group Discussion & Interview, Hari Mohan Prasad, Rajnish Mohan Tata McGraw Hill Education, New Delhi: 2012.
2. Mastering Interviews and Group Discussions, Dinesh Mathur CBS Publication, 2017.
3. Technical Interviews ,Anil Kumar Maini.,Excel with Ease. Pearson, 2011.

#### **Reference Books:**

1. Group Discussions and Interviews, AnandGanguly RPH, 2014.
2. The Interview Book: Your Definite Guide to the Perfect Interview Technique, James Innes. Prentice Hall Business, 2009.

#### **Course outcomes:**

On completion of the course students will be to:

- CO1:** Learn structure and format for effective communications, using e-mail for business communication; standard e-mail practices; language in e-mail, using internet for collecting information; referencing while using internet materials for project reports; writing for media.
- CO2:** Deliver effective power-point presentation.
- CO3:** Take part in Interview through telephone/video-conferencing.
- CO4:** Become proficient to face interviews and model group discussions through the choice of appropriate programmers.

**Appendix-I**  
**Professional elective courses (PEC) for 6<sup>th</sup> semester**

Course code	PEC-CE-611(a)				
Category	Professional Elective Courses				
Course title	Irrigation Engineering				
Scheme and Credits	L	T	P	Credits	Semester-VI
	2	1	0	3	
Pre-requisites (if any)	Fluid Mechanics-II (ESC-CE-402), Hydrology and Ground water (PCC-CE-506)				

**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	Introduction, Types of Irrigation systems, methods of irrigation.	<b>3L+1T</b>
<b>2.</b>	<b>Water requirements of crops:</b> Crop period or Base period, Duty & Delta of a crop, relation between Base Period, Duty & Delta, Duty at various places, flow Duty & quantity Duty, factors affecting Duty, measures for improving Duty of water, crop seasons, Frequency of irrigation.	<b>4L+2T</b>
<b>3.</b>	<b>Canal Irrigation:</b> Introduction, classification of irrigation canals, Efficient section, certain important definitions, Time factor, Capacity factor, full supply co-efficient, Nominal duty, Channel losses, Examples.	<b>4L+2T</b>
<b>4.</b>	<b>Design of unlined alluvial channels by silt Theories:</b> Introduction, Kennedy's theory, procedure for design of channel by Kennedy's method, Lacey's theory, concept of True regime Initial regime and final regime, design procedure using Lacey's theory, ,Methods of prevention of silt deposition in canals and reservoirs, examples. Lining of Irrigation Cannals : Objectives, advantages and disadvantages of canal lining ,economics and requirements of canal lining, Types of lining, Design of lined Canals- examples	<b>6L+3T</b>
<b>5.</b>	<b>River Engineering:</b> Introduction, types of rivers and their characteristics, classification of rivers, Meanders- causes, Meander parameters, Development of a cut-off, cut-off ratio. Control and Training of Rivers: Concept, objectives. Classification of River Training: Marginal embankment or levees, Guide Bank,	<b>4L+2T</b>

	Groynes or spurs, Artificial cut-off, Pitched Island, Pitching of banks and provision of launched apron, Miscellaneous method such as sills etc. Examples.	
6.	<b>Canal Lining:</b> Objects, types of lining, advantages & disadvantages of canal lining, justification & economics of canal lining.	2L+1T
7.	<b>Water logging &amp; Watershed Management:</b> Introduction, causes & effects, control of water logging, Watershed Management.	2L+1T
8	<b>Water resources planning:</b> India's water resources, water resources development, purpose, classification, functional requirements of multipurpose projects, project formulation, evaluation, future strategies, planning & management strategies.	3L+2T
<b>Total</b>		<b>28L+14T</b>
<b>Total week required</b>		<b>14</b>
<b>No. of week reserved</b>		<b>02</b>

**Books: Text and/or Reference:**

1. *Irrigation Engineering and Hydraulic Structures –By Santosh Kr.Garg.Khanna Publishers.*
2. *Irrigation, water Resources and water Power Engineering – By Dr. P.N.Modi- Standard Book House*
3. *Water Resource Systems, Planning and analysis By D.P. LuchesJery R. Stedinger, D.A. Haith, Prntice Hall, Inc, Englewood cliffs, New Jersey*
4. *Water Resources Engineering – Ralph A. Wurbs and Wesley P. James- Prentice Hall of India.*
5. *Water Resources Engineering- Larry W. Mays – John Wiley & Sons, Inc.*

**Course Outcomes:**

At the end of this course, students will be able to

**CO1:** Understand about different types of irrigation & factors for different types of crop.

**CO2:** Design lined & unlined channel section.

**CO3:** Design unlined canal section on alluvial soil by silt theories.

**CO4:** Gain knowledge on river engineering & river training works.

**CO5:** Gain knowledge on canal lining & its advantages.

**CO6:** Learn about water logging & water planning & management.

<b>Course code</b>	<b>PEC-CE-611(b)</b>				
<b>Category</b>	<b>Professional Elective Courses</b>				
<b>Course title</b>	<b>Ground Water</b>				
<b>Scheme and</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Semester-VI</b>

Credits	2	1	0	3	
Pre-requisites (if any)	Hydrology & Ground Water (PCC-CE 506)				

### Theory Syllabus:

Module	Course Content	Lecture / Tutorial Period
1.	<b>Hydrological Parameters:</b> Introduction – Water bearing Properties of Rock – Type of aquifers – Aquifer properties – permeability, specific yield, transmissivity and storage coefficient – Methods of Estimation– Ground water table fluctuation and its interpretations – Groundwater development and Potential in India – GEC norms	6L+3T
2.	<b>Well Hydraulics:</b> Objectives of Groundwater hydraulics – Darcy’s Law – Groundwater equation – steady state flow – Dupuit Forchheimer assumption – Unsteady state flow – Theis method – Jacob method -Slug tests – Image well theory – Partial penetrations of wells.	8L+4T
3.	<b>Couples Flow and Transport:</b> Density Driven Flow, Freshwater/Saltwater Interaction, Heat Transport and Groundwater Flow.	7L+3T
4.	<b>Groundwater Management:</b> Need for Management Model – Database for groundwater management –groundwater balance study – Introduction to Mathematical model – Conjunctive use – Collector well and Infiltration gallery	7L+4T
<b>Total</b>		<b>28L+14T</b>
<b>Total week required</b>		<b>14</b>
<b>No. of week reserved</b>		<b>02</b>

### Books: Text and/or Reference:

Raghunath H.M., “Ground Water Hydrology”, New Age International (P) Limited, New Delhi, 2010.

Todd D.K., “Ground Water Hydrology”, John Wiley and Sons, New York, 2000

Fitts R Charles, “Groundwater Science”. Elsevier, Academic Press, 2002.

Ramakrishnan, S, Ground Water, K.J. Graph arts, Chennai, 1998.

### Course Outcomes:

At the end of this course, students will be able to

CO1: Understand aquifer properties and its dynamics after the completion of the course. It gives an exposure towards well design and practical problems of groundwater aquifers.

CO2: Understand the importance of artificial recharge and groundwater quality concepts.

CO3: Construct mathematical model & balance study.

Course code	PEC-CE611 (c)				
Category	Professional Elective Course (PEC)				
Course title	Structural Analysis-II				
Scheme and Credits	L	T	P	Credits	Semester – VI
	2	1	0	3	
Pre-requisites (if any)	Structural Mechanics (ESC-CE 401), Structural Analysis-I (PCC-CE505)				

### Theory Syllabus:

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	<b>Arches:</b> Introduction, Three hinged arch, Two hinged arch and fixed arch, Deflection of Arch.	<b>4L+1T</b>
<b>2</b>	<b>Deflection of beam by conjugate beam method.</b>	<b>4L+1T</b>
<b>3</b>	<b>Column analogy method and its application.</b>	<b>4L+1T</b>
<b>4</b>	<b>Moment distribution method:</b> stiffness factor, distribution and carry-over factor, solution of continuous beam, effect of settlement and rotation of support, frames with or without side sway.	<b>10L+4T</b>
<b>5</b>	<b>Slope Deflection Method:</b> Development of slope deflection equations, solution of continuous beam, effect of settlement and rotation of support, frames with or without side sway.	<b>10L+4T</b>
<b>6</b>	<b>Influence line diagram:</b> Redundant structures(Beams)	<b>4L+1T</b>
<b>7</b>	<b>Portal &amp; Cantilever Method:</b> Vertical Frame Analysis, Horizontal Sway Analysis	<b>6L+2T</b>
	<b>Total</b>	<b>42L+14T</b>
	<b>No. of weeks Required</b>	<b>14</b>
	<b>No. of weeks in Hand</b>	<b>2</b>

### Text/Reference Books:

1. Theory of structures: by S.P.Timoshenko
2. Theory of structures: by S.Ramamurthum.
3. Mechanics of structures: by Thadani
4. Indeterminate structural analysis: by Kinney
5. Statically indeterminate structures: by C.K.Wang

6. Basic structural analysis: by C.S. Reddy
7. Matrix method of structural analysis: by M.B.Kanchi
8. Structural analysis – A matrix approach by G.S.Pandit and Gupta
9. Theory of structures: by Vazirani and Rathwani Vol. II and Vol. III.
10. Intermediate structural Analysis: by Wang.
11. Structural Analysis Vol.II: by S.S. Bhavikatti
12. Basic Structural Analysis by Wilber, Norrish

### Course Outcomes:

On completion of the course students will be able to

CO1: Analyze determinate and indeterminate arches.

CO2: Determine the deflection of indeterminate structures.

CO3: Impart knowledge about various methods for analyzing of indeterminate structures.

CO4: Draw the influence line diagram of indeterminate beam.

CO5: Understand the approximate method of analysis of vertical multi-storied frame.

Course code	PEC-CE 611(d)			
Category	Professional Elective Courses			
Course title	Design of Concrete Structures			
Scheme and Credits	T	P	Credits	Semester-VI
	1	0	3	
Pre-requisites (if any)	Concrete Technology			

### Theory Syllabus:

<b>Sl. No.</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<p><b>Introduction:</b> Principles of design of reinforced concrete members - Working stress and Limit State method of design.</p> <p><b>Working stress method of design:</b> Basic concepts and IS code provisions for design against bending moment and shear forces - Balanced, under reinforced and over-reinforced beam/ slab sections; design of singly and doubly reinforced sections.</p>	<b>8L+3T</b>

2.	<b>Limit state method of design:</b> Basic concepts and IS code provisions (IS:456) for design against bending moment and shear forces; concepts of bond stress and development length; Use of ‘design aids for reinforced concrete’ (SP:16).	<b>4L+1T</b>
3.	<b>Analysis, design and detailing of singly reinforced rectangular, ‘T’, ‘L’ and doubly reinforced beam sections.</b>	<b>10L+3T</b>
4.	<b>Design and detailing of one-way and two-way slab panels</b> as per IS code provisions. Design and detailing of continuous beams and slabs as per IS code provisions.	<b>9L+3T</b>
5.	<b>Staircases:</b> Types; Design and detailing of reinforced concrete doglegged staircase.	<b>2L+1T</b>
6.	<b>Design and detailing of reinforce concrete short column</b> of rectangular and circular cross-sections subjected to axial compressive force, combine bending (uni-axial bending and bi-axial bending) and direct stress. <b>Shallow foundations:</b> Types; Design and detailing of reinforced concrete isolated square and rectangular footing for columns as per IS code provisions.	<b>9L+3T</b>
	<b>Total</b>	<b>42L+ 14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

#### Text/Reference Books:

1. IS: 456-2000 - “Indian Standard Plain and reinforced concrete – code of practice”
2. SP: 16-2000 - “Design aids to IS: 456”
3. *Design of Reinforced Concrete Structures* by S. Ramamrutham
4. *Reinforced concrete Design* by Mallick & Gupta
5. *Reinforced concrete Limit state design* by Ashok K. Jain
6. *Limit State Design of Reinforced Concrete* by P.C. Varghese
7. *Reinforced Concrete Design* by Pillai and Menon [TMH]
8. *Reinforced concrete* by S.N.Sinha [TMH]

#### Course Outcomes:

On completion of the course students will be able to,

**CO1:** gather basic knowledge of reinforce concrete design and will also be able to design single reinforced and double reinforced beam section by using working stress method.

**CO2:** Understand the principal of limit state method of design and apply for design and detailing of single reinforced, double reinforced, ‘T’ and ‘L’ beam section for flexure and shear according to IS 456, 2000 provision.

**CO3:** Design and detailing of one-way, two-way slab and continuous slab panels as per IS code

provisions.

**CO4:** Design and detailing of compressive member-column subjected to axial compressive force, combine bending (single axial bending and by axial bending) and direct stress as per IS code provision.

**CO5:** Understand different types of stair case and will also be able to design and detailing of reinforced concrete doglegged staircase under its self-weight and imposed lode.

**CO6:** Understand different types of foundation and its application and will also be able to design and detailing of reinforced concrete isolated square and rectangular footing for columns as per IS code provisions.

Course code	PEC-CE611 (e)				
Category	Professional Elective Course (PEC)				
Course title	Composite Structure				
Scheme and Credits	L	T	P	Credits	Semester – VI
	2	1	0	3	
Pre-requisites (if any)	Structural Mechanics (ESC-CE 401)				

#### Theory Syllabus:

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	<b>Introduction to composite materials:</b> Definitions, History, Lamina and Laminate, General characteristics of FRPs, Micromechanics and Micromechanics, Application of composites.	<b>8L+2T</b>
<b>2</b>	<b>Elastic properties of lamina:</b> Introduction, Volume and Weight fractions, Assumptions and laminations, Longitudinal strength and stiffness, Transverse and in plane shear modulus, Stress-strain relationship	<b>4L+1T</b>
<b>3</b>	<b>Analysis of laminated composites:</b> Basic assumption, Strain-Diplacement relationship, Equilibrium equations, Laminated stiffness, Determination of Lamina stiffness and strains.	<b>4L+1T</b>
	<b>Analytical Methods of laminated plate:</b> Introduction, Classical Laminated Theory , Basic assumption, Equilibrium equations of laminated plates, Bending of composite plates, Bending of composite plates	<b>6L+2T</b>
<b>4</b>	<b>Finite Element Analysis of composite structures:</b> Introduction, The Finite Element Method, Basic step, Static analysis, Free vibration analysis	<b>10L+4L</b>



5	Analyses of laminated composites by First order shear deformation theory and Higher order shear deformation theory.	10L+4L
	<b>Total</b>	<b>42L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

**Text/Reference Books:**

1. Mechanics of Composite Materials & Structure by Madhujit Mukhopadhyay
2. Design and Manufacture of Composite Structures by G. Eckold
3. Composite Structures of Steel and Concrete: Beams, Slabsm Columns and Frames for Buildings by R.P Jonshon
4. The Analysis of laminated Composite Structures by Calcote, L R., Von – Nostrand Reinhold Company, New York 1998.
5. Mechanics of Composite Materials by Autor K. Kaw, CRC Press, 2006

**Course Outcomes:**

On completion of the course students will be able to

CO1: Acquire basic understanding of composites materials and its mechanical behavior.

CO2: Calculate the elastic moduli of composites.

CO3: Compute the stress and strain of laminated composites.

CO4: Apply analytical methods for analysis of laminated composite plate structures.

CO5: Employ the application of finite element method for analysis of composite structures.

CO6: Impart knowledge about first order and higher order shear deformation theory of laminated composite structures.

Course code	PEC-CE611 (f)				
Category	Professional Elective Courses				
Course title	Theory of Plates and Shells				
Scheme and Credits	L	T	P	Credits	Semester-VI
	3	1	0	3	
Pre-requisites (if any)	Structural Mechanics (ESC-CE 401), Structural Analysis-I (PCC-CE 505)				

**Theory Syllabus:**

Module	Course Content	Lecture / Tutorial Period
1	Introduction to thin plates, Stress strain relations, strain displacement relation, equations of equilibrium, small deflection theory, virtual work principle, Classical plate theory, FSDT, HSDT. Pure bending and cylindrical bending of isotropic rectangular plates, Energy method, Navier and Levy solutions of rectangular plates.	11L+3T
2	Bending of circular plates. Bending analysis of laminated composites plates.	10L+4T
3	Approximate solution methods for plate problems. Shell behavior, shell surfaces and characteristics, classification of shells equilibrium equations in curvilinear co-ordinates. Stress-strain & force displacement relations. Membrane analysis of shells of revolution.	11L+4T
4	Cylindrical shells under different loads. Shallow shells, membrane solution of elliptic paraboloids and hyperboloids. Solution of some typical problems. Introducing to stability of shells.	10L+3T
	<b>Total</b>	<b>42L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

**Books: Text and/or Reference:**

1. S. Timoshenko and SW Krieger, "Theory of Plates and Shells", McGraw-Hill Publishing Company.
2. R Szilard, "Theories and Applications of Plate Analysis – Classical, Numerical and Engineering Methods", John Wiley & Sons Publishing Company.
3. GS Ramaswamy, "Design & Construction of Concrete Shell Roofs", McGraw-Hill Publishing Company.
4. JE Glibson, "Theory of Cylindrical Shells", North-Holland Publishing Co.
5. NK Bairagi, "Shell Analysis", Khanna Publishers.

**Course Outcomes:**

At the end of this course, students will be able to

CO1. Understand the concept of displacement field approximation, stress resultants, equilibrium equations.

CO2. Describe the governing equation for an isotropic rectangular plate, Navier and Levy solution for rectangular plate.

CO3. Understand bending analysis of circular and laminated composite plates. Approximate methods of analysis for plates.

CO4. Understand the concept of shell behavior, surfaces and characteristics, curvilinear co-ordinates.

CO5. Understand the membrane theory of elliptical, paraboloidal and hyperboloidal shells.

Course code	PEC-CE 611(g)				
Category	Professional Elective Courses				
Course title	Advanced Soil Mechanics and Foundation Engineering				
Scheme and Credits	L	T	P	Credits	Semester-VI
	2	1	0	3	
Pre-requisites (if any)	Basic Soil Mechanics				

**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture/ Tutorial Period</b>
<b>1.</b>	<b>Earth Pressure Theories:</b> Plastic equilibrium of soil, Earth pressure at rest , Active and passive Earth pressure, Rankine's and Coulomb's Earth pressure theories, Wedge method of analysis, Numerical problems.	<b>4L+2T</b>
<b>2.</b>	<b>Retaining Wall and Sheet pile structures:</b> Proportions of retaining walls, stability checks, cantilever and anchored sheet piles, free earth and fixed earth method of analysis of anchored bulk heads , coffer dam structures, types and suitability.	<b>5L+1T</b>
<b>3.</b>	<b>Stability of slopes:</b> Analysis of finite and infinite slopes, Swedish and Friction Circle method, Taylor's stability number, Use of Method of slices, Numerical problems.	<b>4L+2T</b>
<b>4.</b>	<b>Site Investigation and Soil Exploration:</b> Planning of sub-surface exploration, methods, sampling, samples, In-situ tests: SPT, SCPT, DCPT, Plate load test, Bore log, preparation of sub-soil Investigation report.	<b>5L+1T</b>
<b>5.</b>	<b>Foundations:</b> Classification, selection- shallow and deep foundations. Shallow foundations : Bearing capacity, Terzaghi's bearing capacity theory, effect of water table, eccentricity of load, foundation shape on bearing capacity, Bearing capacity as per IS 6403 recommendations. Numerical problems.	<b>4L+2T</b>
<b>6.</b>	<b>Settlement:</b> Immediate and consolidation settlement, settlement in various types of soil, IS-8009 recommendations. Numerical problems.	<b>2L+2T</b>
<b>7.</b>	<b>Allowable bearing capacity:</b> Definition, Determination of allowable bearing capacity from in-situ test- SPT, SCPT and Plate load test.	<b>2L</b>

<b>8.</b>	<b>Deep foundations:</b> Pile - Types, Classification based on material, Installation, Determination of load carrying capacities of piles by static and Dynamic formulae, Pile group - Group efficiency, Negative skin friction, Pile load test. Numerical problems.	<b>4L+2T</b>
	<b>Total</b>	<b>30 L+12T</b>
	<b>No. of Week Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

**Books: Text and/or Reference:**

1. *Principles of Soil Mechanics & Foundation Engineering* by – V.N.S. Murthy (UBS Publishers).
2. *Soil Mechanics & Foundation Engineering* by – B.C.Punmia (Laxmi Publications).
3. *Introduction of Soil Mechanics* by- B.M.Das (Galgotia Publications).
4. *Soil Mechanics* by – T.W.Lambe & R.V.Whitman.
6. *Basic & Applied Soil Mechanics* by- Gopal Ranjan & A.S.R.Rao (Willes EasternLtd.)
7. *Foundation Analysis & Design* By J.E. Bowels ( Mc Graw Hill)
8. *Principles of Foundation Engg.* By B.M. Das (PWS Publishing)

**Course Outcomes:**

At the end of this course, students will be able to

- CO1: Explain Rankine's and Coulomb's earth-pressure theories and apply wedge method to solve numerical problems.
- CO2: Analyze stability of slope by Swedish slip circle method and Taylor's stability number.
- CO3: Develop soil-investigation report by investigating, exploring and testing site soil.
- CO4: Evaluate bearing capacity of shallow foundation by field test and by analytical formulations.
- CO5: Examine immediate and consolidation settlement in different types of soil.
- CO6: Evaluate Pile capacity from static and dynamic formulations.

Course code	PEC-CE 611(h)				
Category	Professional Elective Courses				
Course title	Environmental Geo-technology				
Scheme and Credits	L	T	P	Credits	Semester-VI
	3	0	0	3	
Pre-requisites (if any)	Basic Soil Mechanics, Environmental Engineering-I.				

**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture/ Tutorial Period</b>
<b>1.</b>	<b>Fundamentals of Geo-environmental Engineering:</b> Role of soil in geo-environmental applications – importance of soil physics, soil chemistry, hydrogeology, biological process. Sources and type of ground contamination, impact of ground contamination on geo-environment - case histories on geo-environmental problems.	<b>3L</b>
<b>2.</b>	<b>Soil-Water-Contaminant Interaction:</b> Soil mineralogy characterization and its significance in determining soil behavior. soil-water interaction and concepts of double layer – forces of interaction between soil particles. Concepts of unsaturated soil – importance of unsaturated soil in geo-environmental problems, measurement of soil suction, water retention curves, water flow in saturated and unsaturated zone. Soil-water-contaminant interactions and its implications. Factors effecting retention and transport of contaminants.	<b>14L</b>
<b>3.</b>	<b>Waste Containment System:</b> Evolution of waste containment facilities and disposal practices. Site selection based on environmental impact assessment – different role of soil in waste containment – different components of waste containment system and its stability issues. Property evaluation for checking soil suitability for waste containment, design of waste containment facilities.	<b>10L</b>
<b>4.</b>	<b>Contaminant Site Remediation:</b> Site characterization – risk assessment of contaminated site, remediation methods for soil and groundwater. Selection and planning of remediation methods – some examples of in-situ remediation.	<b>6L</b>
<b>5.</b>	<b>Advanced Soil Characterization:</b> Contaminant analysis - water content and permeability measurements. Electrical and thermal property evaluation. Use of GPR for site evaluation - introduction to geotechnical centrifuge modeling.	<b>9L</b>
	<b>Total</b>	<b>42L</b>
	<b>No. of Week Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

**Books: Text and/or Reference:**

1. *Geotechnical and Geo-environmental Engineering Handbook* by Rowe R.K. (Kluwer Academic Publications, London).
2. *Geo-environmental Engineering, Principles and Applications* by Reddi L.N. and Inyang, H. I. (Marcel Dekker Inc. New York).
3. *Geo-environmental Engineering, Contaminated Soils, Pollutant Fate, and Mitigation* by Yong, R. N. (CRC Press, New York).

4. *Geo-environmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies* by Sharma H.D. and Reddy K.R., (John Wiley & Sons, Inc., USA).
5. *Fundamentals of Soil Behavior* by Mitchell, J. K. (Wiley).

#### Course Outcomes:

At the end of this course, students will be able to

CO1: Explain soil composition, soil structure and its behavior.

CO2: Identify contaminant transport mechanisms in soils.

CO3: Design waste containment facility.

CO4: Justify site investigation techniques for characterization of contaminated site.

CO5: Interpret the principles of treatment techniques for soil and ground water.

CO6: Explain contaminant analysis briefly.

Course code	PEC-CE611 (i)				
Category	Professional Elective Courses				
Course title	Advance Water & Waste Water Technology				
Scheme and Credits	L	T	P	Credits	Semester-VI
	2	1	0	3	
Pre-requisites (if any)	Environmental Science , Environmental Engineering-I Environmental Engineering-II				

#### Theory Syllabus:

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	<b>Water</b> – uses and requirement, Sources, Qualities and quantities, Quality criteria, Intakes and transportation <b>Conventional water treatment methods</b> – Aeration, Sedimentation, Coagulation and flocculation, Filtration, Disinfection – Including design of units, Hardness of water and water softening, other miscellaneous water treatment processes. Water storage and distribution systems, Design of pipe networks, Introduction to plumbing systems in buildings	<b>11L+4T</b>

2	<p>Estimation of quantities of sanitary wastewater and storm water run-off.</p> <p>Sewerage system, Design of sewers, Sewer appurtenances, Materials of sewer construction.</p> <p><b>Quality and characterization of domestic wastewater</b> – different parameters including oxygen demands, Standards of sewage disposal, Legal aspects of water pollution control.</p>	10L+3T
3	<p>Principles of wastewater treatment, Physical, chemical and biological treatment methods, Primary and secondary treatment, Bio-filter, Activated sludge process, Stabilisation pond, Septic tank.</p> <p>Introduction to other treatment processes including digestion and disposal of sludge.</p>	10L+3T
4	<p><b>Principles of stream sanitation.</b></p> <p><b>Introduction</b> : Characteristics of various industrial pollutants and their effects, Environmental impact assessment.</p> <p><b>Wastewater</b> : Theories of industrial wastewater treatment, Neutralisation, Equalisation and proportioning, Removal of suspended solids, Removal of colloidal solids, Removal of inorganic and organic dissolved solids, Disposal of sludge solids, Treatment of typical industrial wastes, Standards for disposal of industrial wastewater.</p>	11L+4T
	<b>Total</b>	<b>42L+14T</b>
	<b>No. of weeks Required</b>	<b>14</b>
	<b>No. of Weeks in hand</b>	<b>2</b>

**Text/Reference Books:**

1. *Environmental Engineering* S.K. Garg -KhannaPub .
2. *Water Supply , Waste Disposal &Environmental Pollution Engineering* – A . K. Chatterjee – Khanna Publication.
3. *Water Supply & Waste Water Disposal* –G .M .Fair , J . C .Geyer ,D . A .Okun . –Jhon Wiley &Sons .
4. *Sanitary Engineering Volume II* by Kshirasagar.
5. *Manual of treatment - A Government of India Publication.*
6. *Water Supply and Sanitary Engineering* By G.S.Birdi
7. *Environmental Engineering* by Mcafffe, Eddy

**Course Outcomes:**

On completion of the course students will be able to,

**CO1:** gather the basic knowledge about the qualities and quantities of water and will also able to understand the conventional water treatment methods like, Aeration, Sedimentation, Coagulation and flocculation, Filtration, Disinfection etc.

**CO2:** Estimate the quantities of sanitary wastewater with its quality and classification and will also able to design of sewers and pipe networks system.

**CO3:** Understand the principle of different wastewater treatments including digestion and disposal of

sludge.

**CO4:** Understand the characteristics of various industrial pollutants and their effects on Environment.

**CO5:** Gather knowledge about industrial wastewater treatment, treatment of typical industrial wastes, and standards for disposal of industrial wastewater.

Course code	PEC-CE611 (j)				
Category	Professional Elective Courses				
Course title	Solid & Hazardous Waste Management				
Scheme and Credits	L	T	P	Credits	Semester-VI
	2	1	0	3	
Pre-requisites (if any)	Environmental Science , Environmental Engineering-I , Environmental Engineering-II				

**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	Identification, characterization and regulatory requirements for disposal of hazardous, nonhazardous and domestic wastes. Transport of Municipal Solid Waste, Routing and Scheduling, Site selection and Geo environmental process and mechanism of attenuation.	<b>12L+4T</b>
<b>2.</b>	Design practices of solid wastes. Tailing dams for disposal of flyash, coal, copper, iron and other metal wastes	<b>10L+4T</b>
<b>3.</b>	Single and double lined landfill design, linear material clay, geosynthetics amended soils and other admixtures. Leachate collection and detection system.	<b>10L+3T</b>
<b>4.</b>	Landfill construction. Construction quality control and performance monitoring. Application of geosynthetics in waste disposal design, Site remediation .Biomedical wastes : definition; category; handling; treatment and disposal Radioactive wastes	<b>10L+3T</b>
	<b>Total</b>	<b>42L+14T</b>
	<b>No. of weeks required</b>	<b>14</b>
	<b>No. of weeks in hand</b>	<b>2</b>

**Text/Reference Books:**

1. *Environmental Engineering S.K. Garg -KhannaPub .*
2. *Water Supply , Waste Disposal &Environmental Pollution Engineering – A . K. Chatterjee – Khanna Publication.*



3. *Water Supply & Waste Water Disposal –G .M .Fair ,J . C .Geyer ,D . A .Okun . –Jhon Wiley & Sons .*
4. *Environmental Engineering by Mcafffe, Eddy*

### Course Outcomes:

On completion of the course students will be able to,

**CO1:** Explain municipal solid waste management systems with respect to its physical properties, and associated critical considerations in view of emerging technologies.

**CO2:** Outline sources, types and composition of solid waste with methods of handling, sampling and storage of solid waste.

**CO3:** Select the appropriate method for solid waste collection, transportation, redistribution and disposal.

**CO4:** Describe methods of disposal of hazardous solid waste and its construction procedure with respect to quality control and performance monitoring.

Course code	PEC-CE611(k)				
Category	Professional Elective Courses				
Course title	Remote Sensing and Geographical Information System				
Scheme and Credits	L	T	P	Credits	Semester-VI
	2	1	0	3	
Pre-requisites (if any)	Nil				

### Theory Syllabus:

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	<b>Remote Sensing:</b> Basic Principles – Introduction, Electromagnetic and its properties, interaction with Earth surface materials, recent developments in Remote sensing, Social and legal implications of Remote sensing, status of Remote sensing, Characteristics of Imaging remote sensing instruments, satellite remote sensing system – a brief over view, other remote sensing satellites.	<b>6L+3T</b>
<b>2</b>	<b>Pre-Processing of Remotely Sensed Data :</b> Introduction, cosmetic operation; Geometric connection and registration, atmospheric correction.	<b>6L+3T</b>

	Image Transforms : Introduction, arithmetic operations, empirically based image transforms, principal component analysis, multiple discriminant analysis etc.	
<b>3</b>	<b>GIS introduction data processing, Analysis and Modeling:</b> Raster based GIS data processing – vector based GIS data processing – Queries – Spatial analysis – Descriptive statistics – Spatial autocorrelation – Quadrant counts and nearest neighbor analysis – Network analysis – surface modeling – DTM; Data Management : The data base designs and approaches, 3 classic data models, nature of geographic data, spatial data models, Databases for GIS; Definitions of GIS – Components of GIS – Geographic data presentation : maps – mapping process – Coordinate systems – Transformations- map projections – geo referencing – data acquisition.	<b>8L+4T</b>
<b>4</b>	<b>Application of GIS in Transportation Engineering:</b> Intelligent information system for road accessibility study, GIS data base design for physical facility planning, Decision support systems for land use planning.  GIS applications in environment impact assessment and environment monitoring, GIS based Highway alignment, GIS based road network planning, GIS based traffic congestion analysis and accident investigation, Utility management.	<b>8L+4T</b>
	<b>Total</b>	<b>28L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of weeks in hand</b>	<b>2</b>

**Text/Reference book:**

1. Lo, C.P. & Yeung A.K.W., *Concepts and Techniques of Geographic Information Systems*, Prentice Hall of India, New Delhi, 2006.
2. Anji Reddy, M., *Remote Sensing and Geographical Information Systems*, B.S.Publications, Hyderabad, 2001.
3. Burrough, P.A., *Principles of Geographical Information Systems*, Oxford Publication, 1998.
4. Clarke, K., *Getting Started with Geographic Information Systems*, Prentice Hall, New Jersey, 2010.
5. DeMers, M.N., *Fundamentals of Geographic Information Systems*, John Wiley & Sons, New York, 2002.
6. *Geo Information Systems – Applications of GIS and Related Spatial Information Technologies*, ASTER Publication Co., Chestern (England), 1992
7. Jeffrey, S. & John E., *Geographical Information System – An Introduction*, Prentice-Hall, 1990
8. Marble, D.F., Galkhs HW & Pequest, *Basic Readings in Geographic Information Systems*, Sped System Ltd., New York, 1984.

**Course Outcomes:**

At the end of the course, students will be able to

**CO1:** understand basic components of remote sensing and GIS.

**CO2:** represent remotely sensed data using available tools.

**CO3:** analyze and process the data for application in different projects.

**CO4:** understand the benefits and shortcomings of using GIS for transportation engineering

**CO5:** develop a strategy to implement GIS for transportation engineering

Course code	PEC-CE611(I)				
Category	Professional Elective Courses				
Course title	Public Transportation System				
Scheme and Credits	L	T	P	Credits	Semester-VI
	2	1	0	3	
Pre-requisites (if any)	Traffic Engineering and Management				

**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	<b>Public Transport:</b> Definitions, modes of public transport and comparison, public transport travel characteristics, trip chaining, technology of bus, rail, rapid transit systems, basic operating elements;	<b>4L+1T</b>
<b>2</b>	<b>Transit Network Planning:</b> Planning Objectives, principles, considerations, transit lines – types, geometry and characteristics, transit routes and their characteristics, timed transfer networks, prediction of transit usage, evaluation of network, accessibility considerations;	<b>8L+4T</b>
<b>3</b>	<b>Transit Scheduling:</b> Components of scheduling process, determination of service requirements, scheduling procedure, marginal ridership, crew scheduling;	<b>8L+5T</b>
<b>4</b>	<b>Transit Agency and Economics:</b> Organizational structure of transit agency, management and personnel, transit system statistics, performance and economic measures, operations, fare structure;	<b>4L+2T</b>

5	<b>Design of Facilities:</b> Design of bus stops, design of terminals – principles of good layout, types of layout, depot location, twin depot concept, crew facilities and amenities.	<b>6L+2T</b>
	<b>Total</b>	<b>28L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of weeks in hand</b>	<b>2</b>

**Text book:**

1. *Traffic Engineering and Transport Planning* - L.R Kadiyali, Khanna Publishers.

**Reference books:**

1. *Introduction to Transportation Planning* – M.J.Bruton; Hutchinson of London Ltd.
2. *Introduction to Urban System Planning* - B.G.Hutchinson; Mc Graw Hill.
3. *Metropolitan transportation planning* – John W. Dickey, Tata Mc Graw Hill, New Delhi, 1975.

**Course Outcomes:**

At the end of the course, students will be able to

**CO1:** identify different components of a public transportation system

**CO2:** plan transit networks and other elements of network route.

**CO3:** do the transit scheduling.

**CO4:** to manage the financial and other requirement of a transit system.

**CO5:** to plan and design of transit facilities or infrastructure.

Course code	PEC-CE611(m)				
Category	Professional Elective Courses				
Course title	Transportation Economics				
Scheme and Credits	L	T	P	Credits	Semester-VI
	2	1	0	3	
Pre-requisites (if any)	Transportation Engineering (PCC-CE 601)				

**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	Introductory Concepts in Transportation Decision Making: Overall transportation project development, budgeting, financial planning, the process of transportation project development, models associated with transportation impact evaluation;	<b>4L+1T</b>
<b>2</b>	Transportation costs - Classification of transportation costs, transportation agency costs, transportation user costs, general structure and behavior of cost functions and road pricing. Estimating Transportation Demand and Supply - supply equilibration, dynamics of transportation demand and supply, elasticity of travel demand and supply, classification of elasticity; Vehicle operating costs: Fuel costs – Maintenance and spares, Depreciation - Crew costs - Value of travel time savings - Accident costs. Economics of traffic congestion - Pricing policy;	<b>10L+6T</b>
<b>3</b>	Economic Analysis; Basic Concepts of Economic Analysis, Principles of Economic Analysis; Cash flow diagrams; Time value of Money; Development of cash flow Diagrams; Methods of Economic Evaluation –Equivalent Uniform Annual Cost Method; Present worth of cost method;- Equivalent uniform annual net return method; Net present value method; Benefit cost ratio method; Rate of Return Method. Applications of these methods to highway projects.	<b>8L+4T</b>
<b>4</b>	Financing of road projects - methods – Private Public Partnership (PPP) - Toll collection - Economic viability of Design-Build-Operate-Transfer Schemes – Risk Analysis – Value for Money analysis - Case Studies.	<b>6L+3T</b>
	<b>Total</b>	<b>28L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of weeks in hand</b>	<b>2</b>

**Text book:**

1. *Traffic Engineering and Transport Planning* - L.R Kadiyali, Khanna Publishers.

**Reference books:**

1. *Transportation Engineering Economics* - Heggie. I. G.; Mc Graw Hill Publishers.
2. *Economic Analysis for Highways* - Winfrey.R; International TextBook Company.
3. *Road User Cost Study*, CRR
4. *Road Project Appraisal, for Developing Countries*, J.W.Dickey, John Wiley & Sons.
5. *IRC: SP: 19; 2001, Manual For Survey, Investigation & Preparation of Road Projects.*

6. IRC: SP: 30, Manual on Economic Evaluation of Highway Projects in India.

**Course Outcomes:**

At the end of the course, students will be able to

**CO1:** understand different model used in transportation budgeting and planning.

**CO2:** estimate various cost component in transportation.

**CO3:** to do financial planning and feasibility study of a transportation project

**CO4:** to analyze different methods available for financing of a transportation infrastructure.

Course code	PEC-CE611(n)				
Category	Professional Elective Courses				
Course title	Pavement Construction and Management				
Scheme and Credits	L	T	P	Credits	Semester-VI
	3	0	0	3	
Pre-requisites (if any)	Transportation Engineering (PCC-CE 601)				

**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	<p><b>Introduction:</b> Components of pavement structure, functions and requirements.</p> <p><b>Construction of Subgrade and Sub-base:</b> Specifications and steps for construction of subgrade, embankment construction, sub-base, quality control tests, Retaining and Breast walls on hill roads.</p> <p><b>Construction of granular layers:</b> Specifications and steps of construction , WBM, WMM, CRM, quality control tests</p> <p><b>Construction of Bituminous Layers:</b> Different types of bituminous layers, specifications and construction technique of bituminous layers, Special structural courses like stone matrix asphalt and mastic asphalt and construction of porous asphalt. quality control tests</p> <p><b>Plants and Equipment:</b> Excavators, graders, compactors, crushers, bituminous hot mix plants, cement concrete mixers, pavers - uses in road construction.</p>	<b>12L</b>
<b>2</b>	<p><b>Construction of Cement Concrete Pavements:</b> Specifications and steps for construction of DLC, Paving Quality Concrete pavements, quality control tests.</p>	<b>6L</b>

	Specifications and steps for construction of White topping, Interlocking concrete block pavements, quality control tests, construction of various types of joints.	
<b>3</b>	<b>Soil Stabilized Pavement Layers:</b> Principles of gradation/proportioning of soil-aggregate mixes and compaction; Design factors, mix design, construction control and quality control checks for mechanical, soil-cement, soil-bitumen and soil-lime stabilization methods. Use of additives, Numerical problems on mix design and applications;	<b>8L</b>
<b>4</b>	<b>Pavement Inventories, Quality Control and Evaluation:</b> Serviceability Concepts; Visual Rating; Pavement Serviceability Index; Roughness Measurements ;Distress Modes – Cracking Rutting Etc; Pavement Deflection – Different Methods and BBD, Skid Resistance, Roughness, Safety – Aspects; Inventory System. Causes of Deterioration, Traffic and Environmental Factors, Pavement Performance Modeling Approaches and Methods of Maintaining WBM, Bitumen and Cement Concrete Roads, Quality Assurance; Quality Control – ISO 9000, Sampling Techniques – Tolerances and Controls related to Profile and Compaction	<b>8L</b>
<b>5</b>	<b>Pavement management system:</b> Components of PMS and their activities; Major steps in implementing PMS; Inputs; Design, Construction and Maintenance; Rehabilitation and Feedback systems; Examples of HDM and RTIM packages; Highway financing; Fund generation; Evaluating alternate strategies and Decision criteria ; Pavement Maintenance Management Components of Maintenance Management and Related Activities – Network and Project Level Analysis; Prioritization Techniques and Formulation of Maintenance Strategies.	<b>8L</b>
	<b>Total</b>	<b>42L</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of weeks in hand</b>	<b>2</b>

**Text books:**

1. *Principles & practice of Highway Engg.*-Dr. L. R. Kadiyali & Dr. N. B. Lal - Khanna Publishers
2. *Construction Equipment and its Management*, S.C. Sharma, Khanna Publishers

**Reference books:**

1. *Hot Mix Asphalt Materials, Mixture Design and Construction'*( 2nd Edition), Freddy L Roberts, Prithvi S Kandhal et.al 'National Asphalt Pavement Association, Research and Education Foundation,
2. *"Construction Planning Equipment and Method*, R. L. Peurifoy and J. S. Clifford, McGraw Hill Book Co. Inc

3. *Relevant IRC Codes and MoRTH Specifications.*

**Course Outcomes:**

At the end of the course, students will be able to

- CO1:** understand steps of construction of flexible pavement as per specification.
- CO2:** understand rigid pavement's construction process and installation of joints.
- CO3:** gain the knowledge of the equipment used for road construction.
- CO4:** prepare quality assurance and quality control during pavement construction.
- CO5:** evaluate the condition of existing pavement and its strengthening.
- CO6:** gain knowledge about pavement management system and financing of road project.



**Detail Syllabus  
(Semester – VII)**

Course code	PCC-CE 701 (Theory) PCC-CE 781 (Sessional)				
Category	Professional Core Course (PCC)				
Course title	Design of Steel Structures (Theory) Design Sessional-II (Sessional)				
Scheme and Credits	L	T	P	Credits	Semester – VII
	2	1	3	4.5	
Pre-requisites (if any)	Structural Mechanics (ESC-CE 401), Structural Analysis-I (PCC-CE505)				

**Theory Syllabus (Design of Steel Structures):**

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	<b>Materials and Specification</b> :-Rolled steel section, types of structural steel , specifications	<b>2L</b>
<b>2</b>	<b>Structural connections:</b> i) Riveted, Welded and Bolted including High strength friction grip bolted Joints. –types of riveted & bolted joints, assumptions, failure of joints ,efficiency of joints, design of bolted ,riveted & welded joints for axial load.  Eccentric connection: - Riveted & bolted joints subjected to torsion & shear, tension & shear, design of riveted, bolted & welded connection.	<b>8L+4T</b>
<b>3</b>	<b>Compression members:</b> Design of compression members, effective lengths about major & minor principal axes, I.S code provisions. Permissible stresses, Design rules, Examples. Design of one component, two components and built up compression members under axial load.	<b>11L+3T</b>
<b>4</b>	<b>Built up columns:</b> Under eccentric loading Design of lacing and batten plates. Different types of Column Bases- Slab Base , Gusseted Base, Connection details.	<b>4L+1T</b>
<b>5</b>	<b>Beams:</b> - Permissible stresses in bending, compression and tension. Design of rolled steel sections, Plated beams. Simple Beam end connections, Beam -Column connections. I.S code provisions	<b>7L+2T</b>

<b>6</b>	<b>Tension members:</b> Design of tension members, I.S code provisions. Permissible stresses, Design rules, Examples.	<b>6L+2T</b>
<b>7</b>	<b>Plastic Analysis of steel structures:</b> Introduction. Plastic hinges & Collapse mechanism, analysis of beams and simple portals frame	<b>4L+2T</b>
	<b>Total</b>	<b>42L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

#### Sessional Syllabus (Design Sessional-II):

<b>Sl. No.</b>	<b>Detailed Description</b>	<b>Sessional Period</b>
<b>1</b>	Problems on general consideration and basic concepts	<b>4P</b>
<b>2</b>	Discussion on different loads ( i.e. wind load , Dead load , live load and others) as per IS800-2007	<b>6P</b>
<b>3</b>	<b>1.</b> Design & drawing of the following components of a roof truss: a. Members of the roof truss. b. Joints of the roof truss members c. Purlines d. Gable bracings e. Column with bracings f. Column base plate g. Column Foundation	<b>32P</b>
	<b>Total</b>	<b>42P</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

#### Text/Reference Books:

1. IS 800 – 2007
2. S.P.: 6(1) – 1964 Structural Steel Sections
3. Pasala Dayaratnam – Design of steel structures A.H.Wheeler& Co Ltd. 1990
4. Ramachandra – Design of steel structures, Vol. I & II
5. B.S.Krishnamachar and D. Ajitha Sinha – Design of steel structures Tata McGraw – Hill publishing Co.
6. S.M.A.Kazmi and R.S. Jindal – Design of steel structures – Prentice Hall of India – 1988.
7. Design Of Steel Structures - S.K.Duggal Tata Mc-GrawHill , New Delhi.
8. Design of Steel Structures – L. S. Negi
9. Design of Steel structures – Arya & Azmani

**Course Outcomes:**

On completion of the course students will be able to

CO1: Design of riveted and welded connections of steel structures.

CO2: Analyze and design of tension members of steel structures.

CO3: Analyze and design of compression members of steel structures.

CO4: Analyze and design of steel beams.

CO5: Impart knowledge about plastic analysis of steel structures.

CO6: Design and detailing of industrial roof truss.

Course code	PCC-CE751				
Category	Professional Core Course (PCC)				
Course title	Computer Application in Civil Engineering-I				
Scheme and Credits	L	T	P	Credits	Semester – VII
	0	0	3	1.5	
Pre-requisites (if any)	NA				

**Syllabus**

1. Hands on experience of building design and frame analysis by using commercial software like STAAD pro
2. Hands on experience of using different estimation commercial software.

**Course Outcome:**

At the end of this course, students will be able to

CO1: Design buildings by using commercial software like STAAD pro.

CO2: Analyze frames by using commercial software like STAAD pro.

Course code	PROJ-INT 791				
Category	Project				
Course title	Internship				
Scheme and Credits	L	T	P	Credits	Semester – VII
	0	0	0	2	
Pre-requisites (if any)	NA				

During the summer vacation after 6th semester, students are ready for industrial experience. Therefore, they may choose to undergo Internship / Innovation / Entrepreneurship related activities. Students may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/ NGO's/ Government organizations/ Micro/ Small/ Medium enterprises to make themselves ready for the industry. Every student is required to prepare a file containing documentary proofs of the activities done by him. The evaluation of these activities will be done by Programmed Head/Cell In-charge/ Project Head/ TPO/ faculty mentor or Industry Supervisor

### **INTERNSHIP GUIDELINES:**

The T&P cell will arrange internship for students in industries/organization after second, fourth and six/seventh semester(s) or as per AICTE/ affiliating University guidelines. Institutions may also device online system for arranging & managing internships. The general procedure for arranging internship is given below:

- **Step 1:** Request Letter/ Email from the office of Training & Placement cell of the college should go to industry to allot various slots of 4-6 weeks during summer vacation as internship periods for the students. Students request letter/profile/ interest areas may be submitted to industries for their willingness for providing the training.
- **Step 2:** Industry will confirm the training slots and the number of seats allocated for internships via Confirmation Letter/ Email. In case the students arrange the training themselves the confirmation letter will be submitted by the students in the office of Training & Placement through concerned department. Based on the number of slots agreed to by the Industry, TPO will allocate the students to the Industry. In addition, the internship slots may be conveyed through Telephonic or Written Communication (by Fax, Email, etc.) by the TPO or other members of the T&P cell / Faculty members who are particularly looking after the Final/Summer Internship of the students.
- **Step 3:** Students on joining Training at the concerned Industry / Organization, submit the Joining Report/ Letters / Email.
- **Step 4:** Students undergo industrial training at the concerned Industry / Organization. In-between Faculty Member(s) evaluate(s) the performance of students once/twice by visiting the Industry/Organization and Evaluation Report of the students is submitted in department office/TPO with the consent of Industry persons/ Trainers.
- **Step 5:** Students will submit training report after completion of internship.
- **Step 6:** Training Certificate to be obtained from industry.
- **Step 7:** List of students who have completed their internship successfully will be issued by Training and Placement Cell

### **EVALUATION THROUGH SEMINAR PRESENTATION/VIVA-VOCE AT THE INSTITUTE**

The student will give a seminar based on his training report, before an expert committee constituted by the concerned department as per norms of the institute. The evaluation will be based on the following criteria:

- Quality of content presented.

- Proper planning for presentation.
- Effectiveness of presentation.
- Depth of knowledge and skills.
- Attendance record, daily diary, departmental reports shall also be analyzed along with the Internship Report.

Seminar presentation will enable sharing knowledge & experience amongst students & teachers and build communication skills and confidence in students.

Course code	PROJ-CE 791				
Category	Project				
Course title	PROJECT-I				
Scheme and Credits	L	T	P	Credits	Semester – VII
	0	0	6	3	
Pre-requisites (if any)	None				

- Project group made up of Students (preferably not more than four in each group) under the guidance of a faculty member need to complete one project during the Semester VII.
- Total marks of the project-I work are 100 and Credit Points are 3.
- At the beginning of the Semester-VII each project group have to submit their project Synopsis. At the end of Semester-VII students have to submit a Project Report. Each group should submit at least three extra copies of Project Report other than their individual copy, one for their Project guide, one for the departmental library and one for the institutional library.
- Each project group should be demonstrated and presented in front of Board of Experts and evaluation will be made on that.

**Appendix-II**  
**Professional elective courses (PEC) for 7<sup>th</sup> semester**

Course code	PEC-CE711(a)				
Category	Professional Elective Courses				
Course title	Advanced Structural Analysis				
Scheme and Credits	L	T	P	Credits	Semester-VII
	3	1	0	3	
Pre-requisites (if any)	Structural Analysis-I (PCC-CE 505), Structural Analysis-II [ PEC-CE611(c) ]				

**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	Elementary theory of elasticity, Stress–strain, Strain-displacement relations, Derivation of equilibrium equations, Various 2D, 3D and spring elements, Use of simple soil mechanics, highways and other stress-strain problems.	<b>6L+2T</b>
<b>2.</b>	<b>Matrix methods in structural analysis:</b> Flexibility and Stiffness method; Elements of matrix algebra; Application of matrix methods to plane trusses, continuous beams & frames.	<b>10L+2T</b>
<b>3.</b>	<b>Finite difference technique:-</b> Application to beams, long columns and beams on elastic foundations.	<b>8L+2T</b>
<b>4.</b>	<b>Introduction of finite Element Technique in structural analysis:-</b> Fundamental concept, Finite Element modeling, Finite element formulation to One Dimensional. <b>Interpolation functions of one dimensional element:-</b> linear, quadratic and cubic interpolation functions.	<b>8L+4T</b>
<b>5.</b>	<b>Finite element solution for two dimensional pin-jointed trusses:-</b> degree of freedom, co-ordinate system, element stiffness, boundary conditions, global stiffness matrix. <b>Finite element solution for beams:-</b> degree of freedom, co-ordinate system, element stiffness, boundary conditions, global stiffness matrix.	<b>10L+4T</b>
	<b>Total</b>	<b>42L+14T</b>
	<b>No.of weeks Required</b>	<b>14</b>
	<b>No. Of weeks in Hand</b>	<b>2</b>

**Books: Text and/or Reference:**

1. *Numerical Methods for Civil Engineers* By Chopra
2. *Numerical Methods* by Madhujit Mukherjee
3. JN Reddy, “*An Introduction to Finite Element Method*”, Tata McGraw Hill.
4. Chandraputla and Belegundu, “*Introduction to Finite Elements in Engineering*”, Prentice Hall.
5. Sinha and Gayen, “*Advanced Theory of Structures*”, Dhanpat Rai & Sons.
6. Madhu B. Kanchi, “*Matrix Method of Structural Analysis*”, Wiley Eastern Limited.
7. Pandit Gupta, “*Structural Analysis*”, Mc. Graw Hill.

**Course Outcomes:**

At the end of this course, students will be able to

CO1: Explain the elementary theory of elasticity, Stress–strain and Strain-displacement relations and equilibrium equations.

CO2: Apply Flexibility and Stiffness matrix methods to plane truss; continuous beam & frames.

CO3: Employ finite difference technique to beams, long columns and beams on elastic foundations.

CO4: Solve one-dimensional and two-dimensional problems using finite element method.

CO5: Apply finite element method for beam problems.

Course code	PEC-CE711(b)				
Category	Professional Elective Courses				
Course title	Structural Dynamics and Earthquake Resistance Structure				
Scheme and Credits	L	T	P	Credits	Semester-VII
	2	1	0	3	
Pre-requisites (if any)	None				

<b>Sl. No.</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	<b>Theory of vibrations</b> -Newton’s Law, D’Alembert principal, Hamilton’s principal, Lagrange principal and its application, Degrees of freedom, Dynamics system and types, Classification of vibration, Harmonic motion.	<b>5L+1T</b>



2	<b>Response of single degree freedom system due to free vibrations:</b> Undamped single degree freedom system, Damped single degree freedom system, Natural frequency, modes of vibration, Logarithmic decrement.	<b>6L+2T</b>
3	<b>Response of single degree freedom system due to harmonic loading:</b> Undamped harmonic excitation, Damped Harmonic excitation, Vibration isolation and Transmissibility. <b>Response due to Transient loading:</b> Duhamel's Integral, Response due to constant force, Rectangular load, Introduction to numerical evaluation of Duhamel's integral of undamped system.	<b>11L+5T</b>
4	<b>Two degree and multiple degree freedom systems,</b> Computation of dynamic response to time dependent forces, Vibration isolation, Vibration absorbers.	<b>10L+3T</b>
5	<b>Principles of earthquake resistant design:</b> Terminology, General principles and Design criteria, Methods of Analysis, Equivalent lateral force method of Analysis for multistoried building as per Indian Standard Code of Practice, Introduction to Response Spectrum Method, Fundamental concepts of Ductile detailing	<b>10L+3T</b>
	<b>Total</b>	<b>42L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

#### Text/Reference Books:

1. *Structural Dynamics* by Mario Paz
2. *Structural Dynamics* by Madhujit Mukhopadhyay
3. *Dynamic of Structures* by Anil K. Chopra
4. *Dynamics of Structures* by Ashok K. Jain
5. *Earthquake-Resistant Design of Structures* by S.K Duggal.

#### Course Outcomes:

On completion of the course students will be able to,

**CO1:** gather the basic knowledge of vibration, vibration system, harmonic motion and some different principles which are applicable for analyzing vibration system

**CO2:** analysis the response of single degree freedom system due to free vibrations, harmonic loading and transient loading.

**CO3:** analysis the response of Two degree and multiple degree freedom systems due to free vibrations, harmonic loading and also able to understand about Vibration isolation, Vibration absorbers.

**CO4:** gather the basic knowledge about Principles of earthquake resistant design and also able to evaluate equivalent lateral force due to earthquake for a multistoried building as per Indian Standard Code of Practice.

Course code	PEC-CE711 (c)				
Category	Professional Elective Courses				
Course title	Prefabricated Building & Structure				
Scheme and Credits	L	T	P	Credits	Semester-VII
	2	1	0	3	
Pre-requisites (if any)	Design of Concrete Structures (PEC-CE611 (d))				

### Theory Syllabus:

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Introduction:</b> Need for prefabrication – Principles – Materials – Modular coordination – Standardization – Systems – Production – Transportation – Erection.	<b>6L+1T</b>
<b>2.</b>	<b>Prefabricated components:</b> Behaviour of structural components – Large panel constructions – Construction of roof and floor slabs – Wall panels – Columns – Shear walls	<b>7L+2T</b>
<b>3.</b>	<b>Design principles:</b> Disuniting of structures- Design of cross section based on efficiency of material used – Problems in design because of joint flexibility – Allowance for joint deformation.	<b>10L+3T</b>
<b>4.</b>	<b>Joint in structural members:</b> Joints for different structural connections – Dimensions and detailing – Design of expansion joints	<b>9L+4T</b>
<b>5.</b>	<b>Design for abnormal loads:</b> Progressive collapse – Code provisions – Equivalent design loads for considering abnormal effects such as earthquakes, cyclones, etc., – Importance of avoidance of progressive collapse.	<b>10L+4T</b>
	<b>Total</b>	<b>42L+14T</b>
	<b>No. of weeks Required</b>	<b>14</b>
	<b>No. of Weeks in hand</b>	<b>2</b>

### Books: Text and/or Reference:

1. Wai Kwong Lau, "Building Construction with Precast Concrete Structural Elements".
2. AM Hass, "Precast concrete: Design and Applications", Applied Science Publishers.
3. Kim S. Elliott, "Precast Concrete Structures".
4. T Koncz, Manual of precast concrete construction, Vols. I, II and III, Bauverlag, GMBH, 1976.
5. Structural design manual, Precast concrete connection details, Society for the studies in the use of precast concrete, Netherland Betor Verlag, 2009.

**Course Outcomes:**

At the end of this course, students will be able to

- CO1. Demonstrate the need for prefabrication with the steps involved.
- CO2. Describe the behavior and construction of various prefabricated components.
- CO3. Design the cross-section of different prefabricated element.
- CO4. Design joints for different structural connections.
- CO5. Design prefabricated elements for abnormal loads with the help of code provisions.

Course code	PEC-CE711 (d)				
Category	Professional Elective Course (PEC)				
Course title	Reliability Analysis of Structures				
Scheme and Credits	L	T	P	Credits	Semester – VII
	2	1	0	3	
Pre-requisites (if any)	Structural Mechanics (ESC-CE 401), Structural Analysis-I (PCC-CE505)				

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	<b>Introduction to Structural Reliability:</b> Role of reliability in civil engineering; Historical background, Fundamentals of Probability theory, Concepts of Structural safety.	<b>4L+1T</b>
<b>2</b>	<b>Probability Theory:</b> Important statistical parameters and their estimations, Random events, Random variables, Functions of random variables, normal, lognormal and extreme value distribution.	<b>4L+1T</b>
<b>3</b>	<b>Basic Structural Reliability:</b> Derivation of stress-strength interface equation, graphical representation, Cornell reliability index, reliability and failure probability computations for simple linear functions.	<b>6L+2T</b>
<b>4</b>	<b>Reliability Methods:</b> Introduction, Basic variables and failure surface, Second moment concepts, First order second moment theory, Hasofer-Lind transformation, Linear and non-linear limit state functions, Solution schemes, geometric interpretation of solution scheme, Rackwitz-Fiessler transformation. First-order second-moment methods (FOSM). Reliability assessment of structural component and simple civil engineering structures.	<b>4L+1T</b>
<b>5</b>	<b>Monte Carlo methods:</b> Generation of random numbers, continuous discrete and jointly distributed variables, application to reliability analysis of concrete structures.	<b>4L+1T</b>

	<b>Total</b>	<b>28L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

### Text/Reference Books:

1. Structural Reliability by R.EMelchers, John Wiley and Sons Ltd., 2018
2. Structural Reliability Analysis and Design by R.Ranganatham, Jaico Publishing House, 2006.
3. Probability, Reliability, and Statistical Methods in Engineering Design by Haldar and Mahadevan, John Wiley & Sons, USA, 2013.

### Course Outcomes:

On completion of the course students will be able to

- CO1: Impart knowledge of fundamentals of structural reliability.  
CO2: Employ concept of probability theory for structural engineering  
CO3: Determine structural reliability using different reliability methods.  
CO4: Apply simulation based method for structural reliability.  
CO5: Design the structures under various uncertainties.

Course code	PEC-CE711(e)				
Category	Professional Elective Courses				
Course title	Railway Engineering				
Scheme and Credits	L	T	P	Credits	Semester-VII
	2	1	0	3	
Pre-requisites (if any)	Surveying-I (PCC CE-301) Surveying-II (PCC CE501)				

### Theory Syllabus:

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Introduction and Location survey:</b> Role of Railway in Transportation, Historical Development of Railway in India, Organization of Indian Railways, Classification of Indian railways (By Tonnage, Gauge length, speed on railway Line). Basic requirements of an ideal Alignment, Factors affecting alignment,	<b>3L+1T</b>

	Preliminary surveys and Engineering surveys on Alignment, final location survey, Construction of new lines.	
2.	<b>Stress in a railway Track:</b> Track Modulus, Stresses in Rails, Sleepers and Ballast, Tractive Resistances, Hauling Capacity of Locomotive.	3L+1T
3.	<b>Permanent way:</b> Requirement of an ideal Permanent way, gauge in a railway track, Different gauge in India and Abroad, Selection of Gauge, railway Track Cross Section, coning Of Wheels, <b>Rails:</b> Function of Rails, Composition of rails, Requirement of Rails, Types of Rail Sections, Comparison of Different types of Rail, Selection of rail, Length of Rail, Corrugated or Roaring rails, Hogged rails, Kink in rails, Buckling of Rails, Rail failures, Wear on Rail. <b>Rail joints and Welding of rails:</b> Requirement of an ideal joint, types of rail joints, welding of rails, advantages of welding of rails, method of welding of rails, length of welded rails. <b>Long welded rails (LWR), Creep of rails:</b> Indication of creep, theories of creep, Effect of creep, Measurement of creep, prevention of creep. <b>Sleepers:</b> Function of sleepers, Requirement of sleepers, classification of sleepers, Advantages and disadvantages of different type of sleepers, Adzing of sleepers, Spacing of sleepers and sleeper density. <b>Track fittings and fastenings:</b> Fish Plate, Spikes, Bolts, Chairs, Blocks, Keys, Bearing Plates. <b>Ballast:</b> Function of Ballast, Requirement of Ballast, Types of Ballast, Size and selection of Ballast, Renewal of Ballast. <b>Subgrade and Formations:</b> function, slopes, Cross-section, Drainage	8L+1T
4.	<b>Geometric Design:</b> Alignment, horizontal curves, super elevation, equilibrium cant and cant-deficiency, Safe Speed on Curves, transition curve, Extra Clearance on Curves, Widening of Gauge on Curves, Gradients and grade compensation. Vertical Curves, check rails on curves.	4L+5T
5.	<b>Points and crossing:</b> Necessity of point and crossings; Turnout: direction and its component, Point or switches: Component and types; Crossing: component and type, number and angle of crossing; Design of Turnouts, sleepers at points and crossings.  Track Junctions and Simple Track Layouts	4L+4T
6.	Track maintenance, Track drainage, Modern methods of track maintenance, Rehabilitation and renewal of track.	3L+1T
7.	<b>Railway Station Yard:</b> Site, requirements, classification of railway stations.	3L+1T

	<b>Signaling and Inter looking:</b> Objectives, principles of signaling, classification and types of signals in stations and yards & methods of interlocking. Control of movement of Train  <b>Level Crossings:</b> Classification, Accidents at Level Crossings and Remedial Measures, Maintenance of Level Crossings	
<b>Total</b>		<b>28L+14T</b>
<b>Total week required</b>		<b>14</b>
<b>No. of week reserved</b>		<b>02</b>

**Books: Text and/or Reference:**

1. *A Text Book of Railway Engineering*, S.C. Saxena, S.P. Arora, Dhanpat Rai Publication
2. *Railway Engineering*, Satish Chandra and M. M. Agarwal, Oxford University Press.

**Course Outcomes:**

At the end of this course, students will be able to

1. Gain knowledge of component of railway track and gauges.
2. Design and analyze the track geometry for a railway line.
3. Design of turnouts at curves.
4. Understand signaling and interlocking process of track system.
5. Understand the process of track maintenance, rehabilitation and renewal of track.

Course code	PEC-CE711(f)				
Category	Professional Elective Courses				
Course title	Airport Planning and Design.				
Scheme and Credits	L	T	P	Credits	Semester-VII
	2	1	0	3	
Pre-requisites (if any)	Transportation Engineering				

## Theory Syllabus:

Module	Course Content	Lecture / Tutorial Period
1	<p><b>Introduction:</b> History, development, policy of air transport, aircrafts, aerodromes, airtransport authorities, air transport activities, air crafts and its characteristics, airport classifications as per ICAO</p> <p><b>Airport Planning:</b> Regional planning-concepts and advantages, location and planning of airport as per ICAO and F.A.A.recommendations, airport Elements - airfield, terminal area, obstructions, approach zone, zoning laws, airport capacity, airport size and site selection, estimation of future air traffic, development of new airport, requirements of an ideal airport layout.</p>	6L+3T
2	<p><b>Runway Design:</b> Wind rose and orientation of Runway, Basic Runway Length and Factors affecting, Correction for elevation, temperature and gradient as per ICAO and FAA, Run way pattern (configuration,) Runway Geometric Design, Runway marking, threshold limits cross section of runway. Runway Intersection Design; Determination of runway capacity and delays. Taxiway and gate capacity.</p> <p><b>Taxiway Design:</b> Factors affecting Taxiway Design, Geometric Design as per ICAO, layout, Exit taxiways, location, Fillets, Separation clearance, Holding Apron, Turn Around. Aprons -locations, size, gate positions, aircraft parking configurations and parking systems, hanger-site selection, planning and design considerations, Fuel storage area, blast pads .wind direction indicator</p> <p><b>Terminal Area Design:</b> Terminal area elements and requirements, terminal building functions, space requirements, location planning concepts, vehicular parking area and Circulation network. passenger requirements at terminal building</p>	8L+4T
3	<p><b>Design of Airport Pavements:</b> Design factors, Calculation of ESWL with different wheel load configurations and methods, Repetition of loads, failure criteria;</p> <p><b>Flexible Pavements Design:</b> US corps of Engineers Method, FAA method;</p> <p><b>Rigid Pavement Design methods:</b> US corps of Engineers method, PCA Method, FAA method, LCN Method and CAN-PCN System.; Overlays;</p> <p><b>Drainage:</b> Surface and subsurface methods, filter materials, Special characteristics and requirements of Airport Drainage.</p> <p><b>Airfield Pavement Maintenance and Rehabilitation:</b> Need, Failures, Evaluation of flexible and Rigid Pavements, Strengthening of Airfield Pavements and maintenance operations.</p>	8L+4T

4	<b>Airport Lighting, Marking, and Signage</b> - Requirements of visual aids, approach lighting system configurations, visual approach slope aids, threshold lighting, Runway and taxiway lighting and marking, airfield signage.	<b>2L+1T</b>
5	<b>Air Travel Demand Analysis:</b> The Demand Analysis, Microanalysis of Air Travel Demand, Calibration of Macro analysis of Air Travel Demand, Disaggregate Models Route Frequency planning. Air travel choice Models, Simultaneous Models of Demand and supply. Optimal Route Frequency Planning.	<b>4L+2T</b>
	<b>Total</b>	<b>28L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of weeks in hand</b>	<b>2</b>

**Text/References books:**

1. *Principles of Pavement Design*, Yoder E.J. and Witczak M. W. John Wiley &-Sons, 1975.
2. *Elementary Hand Book of Aircraft Engines*, A. W. Judge, Chapman and Hall ltd, London.
3. *Airplanes Structures*, A.S. Niles and J.S. Newell, M. W. John Wiley & Sons, New York.
4. *Relevant IRC codes*.
5. *Air Port Engineering*, Norman Ashford and Paul H Wright, M. W. John WHey & Sons.
6. *The Planning and Design of Airports*, Robert Horojeff, McGraw Hill Book Co..
7. *Airport Planning and Design*, S.K. Khanna, Arora and S.S. Jain, Nem Chand & Bros. Roorkee.

**Course Outcomes**

At the end of this course, students will be able to

- CO1:** Understand the regional planning for an airport.
- CO2:** Design the runway length and fix the orientation of it.
- CO3:** Understand the visual aids required for safe landing and takeoff operation of airport.
- CO4:** Analyze air travel demand using mathematical models.
- CO5:** Design the runway pavement
- CO6:** Design the Airport drainage system.

Course code	PEC-CE711(g)				
Category	Professional Elective Courses				
Course title	Geometric Design of Highway				
Scheme and Credits	L	T	P	Credits	Semester-VII
	2	1	0	3	
Pre-requisites (if any)	Transportation Engineering				



**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	Introduction: Classification of rural highways and urban roads. Objectives and requirements of highway geometric design; Design Controls – Topography, Driver characteristics, Vehicle Characteristics, Traffic, Capacity and Level of Service, Design Speed. Objectives of Geometric Design, Cross Section Elements: Design specifications; Pavement Surface characteristics – Skid Resistance, Road Roughness; Camber, Objectives, design standards. Specifications for hill roads.	<b>6L+2T</b>
<b>2</b>	Horizontal Alignment of Roads: Sight Distances – Stopping Sight Distance, Overtaking Sight Distance and Intermediate Sight Distance. Objectives of horizontal curves; Super elevation, super elevation rotation; Extra-widening on Curves; Transition Curves – Objectives and design. Transition Curve setting methods, Introduction to MX Roads software.	<b>6L+4T</b>
<b>3</b>	Vertical Alignment of Roads: Gradients – Types of Gradients, Design Standards; Vertical Curves – Summit Curves, Valley Curves and Design criteria for Vertical Curves; Importance of Sight Distances for Horizontal and Vertical Curves ; Combination of Vertical and Horizontal Curves – Grade Compensation.	<b>8L+4T</b>
<b>4</b>	Geometric Design of Intersections : Types of Intersections; Design Principles for Intersections; Design of At-grade Intersections – Channelization, Objectives; Traffic Islands and Design standards; Rotary Intersection – Concept, Advantages and Disadvantages; Grade separated Interchanges – Types, warrants and Design standards. Acceleration Ramp.	<b>4L+2T</b>
<b>5</b>	Miscellaneous Elements: Requirements of Pedestrians; Pedestrian facilities on Urban Roads; Cycle Tracks – Guidelines and Design standards; Bus bays –Types and Guide lines; Design of On-street and Off street Parking facilities – Guidelines for lay out Design, Traffic Signs and Markings.	<b>4L+2T</b>
	<b>Total</b>	<b>28L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of weeks in hand</b>	<b>2</b>

**Text/Reference Books:**

1. *Principles and Practice of Highway Engineering*, L.R.Kadiyali and N.B.Lal, Khanna, 2007.
2. *Traffic Engineering and Transportation Planning*, L.R.Kadiyali, Khanna Publications, 2007.
3. *Highway Engineering*, C.E.G.Justo and S.K.Khanna, Nem Chand and Brothers.

4. IRC Codes for Signs, Markings and Mixed Traffic Control in Urban Areas.

**Course Outcomes:**

At the end of this course, students will be able to

**CO1:** Design geometric elements of Cross Section of a roadway.

**CO2:** Design Horizontal Alignment of Roads

**CO3:** Design Vertical Alignment of Roads.

**CO4:** Design various tools like median, island, etc. used for traffic management.

**CO5:** Design parking facility, bicycle lane, pedestrian facilities, etc.

**CO6:** Gain knowledge of traffic sign and road marking installation.

Course code	PEC-CE711(h)				
Category	Professional Elective Courses				
Course title	Port and Harbor Engineering				
Scheme and Credits	L	T	P	Credits	Semester-VII
	3	0	0	3	
Pre-requisites (if any)	Nil				

**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	<b>Introduction:</b> Types of water transportation, History of water transportation at world level and at national level, development and policy, Major ports in India, administrative set up.	<b>4L</b>
<b>2</b>	<b>Harbour Planning:</b> Requirements of ports and harbours, classification of harbors, Harbour components, ship characteristics, Characteristics of good harbour and principles of harbour planning, size of harbour, site selection criteria and layout of harbours. Surveys to be carried out for harbor planning.	<b>6L</b>
<b>3</b>	<b>Natural Phenomena:</b> Wind, waves, tides formation and currents phenomena, their generation characteristics and effects on marine structures, silting, erosion and littoral drift.	<b>4L</b>

4	<b>Marine Structures:</b> General design aspects, breakwaters - function, types general design principles, wharves, quays, jetties, piers, pier heads, dolphin, fenders, mooring accessories – function, types, suitability, design and construction features.	8L
5	<b>Docks and Locks:</b> Tidal basin, wet docks-purpose, design consideration, operation of lock gates and passage, repair docks - graving docks, floating docks.	6L
6	<p><b>Navigational Aids:</b> Requirements of signals, fixed navigation structures, necessity of navigational aids, light houses, beacon lights, floating navigational aids, light ships, buoys, radar;</p> <p><b>Port facilities:</b> Port development, port planning, port building facilities, transit sheds, warehouses, cargo handling facilities, container handling terminal facilities, shipping terminals, inland port facilities.</p> <p><b>Inland waterways:</b> Inland water transportation in India, classification of waterways, economics of inland waterways transportation, national waterways.</p>	8L
7	<b>Dredging and Coastal Protection:</b> Classification, types of dredgers, choice of dredger, uses of dredged materials, coastal erosion and protection, sea wall, revetment, bulkhead, coastal zone and beach profile;	6L
<b>Total</b>		<b>42L</b>
<b>No. of Weeks Required</b>		<b>14</b>
<b>No. of weeks in hand</b>		<b>2</b>

***Text/Reference Books:***

1. *Dock and Tunnel Engineering*, by R. Srinivasan and S. C. Rangwala. Charotar Pub House.
2. *A Course in Docks and Harbor Engineering* by S. P. Bindra. Dhanpat Rai & Sons publication

**Course Outcomes:**

At the end of this course, students will be able to

- CO1:** To understand the fundamentals of planning and design of various marine structures.
- CO2:** To identify natural ocean phenomenon which affect the harbor operations.
- CO3:** Facilitate the navigational aids required at port.
- CO4:** To design protection structures required at harbors.
- CO5:** To gather knowledge of maintenance techniques at harbor.

Course code	PEC-CE-711(i)				
Category	Professional Elective Courses				
Course title	Hydraulic Structures & Flood Control Engineering				
Scheme and Credits	L	T	P	Credits	Semester-VII
	2	1	0	3	
Pre-requisites (if any)	Hydrology and Ground Water [ PCC-CE-506 ] Irrigation Engineering [ PEC-CE-611(a) ]				

### Theory Syllabus:

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
1.	Definition of Dam, Classification of Dams, Problems in Dam Construction, Factors governing the selection of a particular type of dam	<b>2L+1T</b>
2.	<b>Selection of Dam Site:</b> Site investigations, initial study, reconnaissance survey, geophysical investigations, preliminary selection, evaluation of selected site - various types of foundation testing, field testing and borrow pit investigations, detailed investigations; assessment of foundation characteristics and suitability; selection of type of dam.	<b>2L+1T</b>
3.	<b>Gravity Dam:</b> Definition, Features of some important gravity dams, Forces acting on a gravity dam, estimation of forces due to: self-weight, water pressure on upstream and downstream face, Uplift pressure, wave pressure, silt pressure, wind pressure, earthquake forces, hydrodynamic forces; Stability analysis - load combinations, codal provisions, modes of failures - overturning, sliding, tension and compression failures, factors of safeties, principal stresses; Elementary profile of a gravity dam - forces acting, minimum base width - no tension, no sliding basis, principal stresses	<b>6L+3T</b>
4.	<b>Embankment Dams:</b> Definitions, Features of some important embankment dams; Types of embankment dams and their sectional features; Design criteria; Freeboard - necessity, estimation procedure; Seepage analysis - Laplace's flow equations, drainage blanket and rock toe, phreatic line, graphical procedure of drawing phreatic line, estimation of seepage loss; Stability analysis of embankment dams – slip circle method; Seepage Control - cut-offs, slurry trench, sheet piling, grouting, slope protection.	<b>4L+2T</b>

5.	<b>Diversion Headworks:</b> Necessity and uses, different types, layout and different components; weirs on permeable foundation, Creep theories, Khosla's method; Different types of modules, Canal escapes, Silt control devices.	<b>4L+2T</b>
6.	<b>Spillways and Energy Dissipation Structures:</b> Necessity, types, selection, spillway gates; High overflow ogee spillway - profile, discharge computation, flow equations, factors affecting coefficient of discharge, codal provisions. stilling basins (USBR and BIS) types	<b>2L+1T</b>
7.	Floods and their estimation, Flood Control Measures	<b>2L+1T</b>
8	Flood Forecasting Techniques	<b>3L+1T</b>
9	Flood Preparedness and Emergency Evacuation, Engineering Economy in Water Resources Planning	<b>3L+2T</b>
<b>Total</b>		<b>28L+14T</b>
<b>Total week required</b>		<b>14</b>
<b>No. of week reserved</b>		<b>02</b>

#### **Books: Text and/or Reference:**

*Irrigation Engineering and Hydraulic Structures –By Santosh Kr.Garg.Khanna Publishers.*  
*Irrigation, water Resources and water Power Engineering – By Dr. P.N.Modi- Standard Book House*  
*Hydrology & Flood Control Engineering by S.K.Garg, Khanna Publishers*  
*A Textbook of Water Power Engineering by R.K.Sharma & T.K.Sharma*

#### **Course Outcomes:**

At the end of this course, students will be able to

- CO1:** Gain knowledge about different types of dam & its selection.
- CO2:** Design gravity dam by considering different types of forces.
- CO3:** Design embankment dam by considering stability & other consideration.
- CO4:** Gain knowledge on spillways & energy dissipated structures.
- CO5:** Understand about flood forecasting & its studies.

Course code	PEC-CE-711(j)				
Category	Professional Elective Courses				
Course title	River Engineering				
Scheme and Credits	L	T	P	Credits	Semester-VII
	2	1	0	3	
Pre-requisites (if any)	Hydrology and Ground Water [ PCC-CE-506 ] Irrigation Engineering [ PEC-CE-611(a) ]				

### Theory Syllabus:

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
1.	Introduction, classification of Rivers, Mechanics of alluvial rivers including channel and flood plain features, Sediment transport and budgets, River morphology and various classification schemes.	<b>4L+2T</b>
2.	<b>Behavior of Rivers:</b> Introduction, River Channel patterns, Straight river channels, causes, characteristics and shapes of meanders and control, cutoff, Braided Rivers, Bed forms, Instability of rivers, Hydraulic geometry, Delta formation and control.	<b>6L+3T</b>
3.	Mechanics of Alluvial Rivers, Rivers and restoration structures, Socio- cultural influences and ethics of stream restoration.	<b>6L+3T</b>
4.	Bio- engineering Techniques, Classification review, Natural Channel Design Analysis, Time Series, analysis of flow, Sediment and channel geometry data.	<b>6L+3T</b>
5.	<b>River Training and Protection Works:</b> Introduction, Classification of River Training, Types of training works, Protection for Bridges with reduced waterway, Design of Guide Band, embankment and spurs/dampners and other river/ flood protection works.	<b>6L+3T</b>
<b>Total</b>		<b>28L+14T</b>
<b>Total week required</b>		<b>14</b>
<b>No. of week reserved</b>		<b>02</b>

**Books: Text and/or Reference:**

*River Behaviour Management and Training (Vol. I & II), CBI&P, New Delhi.*

*Irrigation & Water Power Engineering- B. C. Punmia and Pande B. B. Lal.*

*River Engineering by Margeret Peterson*

*Principles of River Engineering by ( the non tidel alluvial) PH Jameen*

*Irrigation Engineering and Hydraulic Structures –By Santosh Kr.Garg.Khanna Publishers.*

*Irrigation, water Resources and water Power Engineering – By Dr. P.N.Modi- Standard Book House*

**Course Outcomes:**

At the end of this course, students will be able to

CO1: Gain knowledge about mechanism and morphology of rivers.

CO2: Understand the behavior of rivers and its characteristics throughout the flow.

CO3: Design restoration structure & understand mechanics of alluvial rivers.

CO4: Design River training works & flood control units as it's required.

Course code	PEC-CE 711(k)				
Category	Professional Elective Courses				
Course title	Rock Mechanics & Tunneling				
Scheme and Credits	L	T	P	Credits	Semester-VII
	3	0	0	3	
Pre-requisites (if any)	Engineering Geology, Basic Soil Mechanics.				

**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture/ Tutorial Period</b>
<b>1.</b>	<b>Introduction:</b> objective, scope and problems of Rock Mechanics. Classification by Origin, Lithological, Engineering. <b>Rock exploration:</b> Rock coring, geophysical methods. Laboratory testing of rocks: Compressive strength, tensile strength and flexural strength tests.	<b>8L</b>

2.	<b>Strength and failure of rocks:</b> Griffiths theory, Coulombs theory, Rheological methods. In-situ tests on rock mass. Deformation characteristics of rocks, instrumentation and measurement of deformation of rocks. <b>Permeability characteristics:</b> Interstitial water on rocks, unsteady flow of water through jointed rock mass.	<b>10L</b>
3.	<b>Analysis of stresses:</b> Mechanical, thermal and electrical properties of rock mass. Correlation between laboratory and field properties, Thick wall cylinder formulae, Kreish equation, Green span method. Openings in rock mass and stresses around openings. Pressure tunnels, development of plastic zone. Rock support needed to avoid plastic deformation. Lined and unlined tunnels. Underground excavation and subsidence.	<b>12L</b>
4.	<b>Rock mechanics applications:</b> Bearing capacity of homogeneous as well as discontinuous rocks. Support pressure and slip of the joint. Delineation of types of rock failure. Unsupported span of underground openings, pillars. Rock slopes. Rock bolting. Plastic mechanics. Tunnels, shapes, usages, Methods of Construction, Problems associated with tunnels, tunneling in various subsoil conditions and rocks.	<b>12L</b>
	<b>Total</b>	<b>42L</b>
	<b>No. of Week Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

#### **Books: Text and/or Reference:**

1. *Introduction to Rock Mechanics* by R.E.Goodman (John Wiley & Sons).
2. *Engineering in Rocks for Slopes, Foundation and Tunnels*, Editor T.Ramamurthy, (Prentice Hall India Pvt. Ltd.).
3. *Fundamentals of Rock Mechanics, Fourth Edition*, by Jaeger, Cook and Zimmerman, (Blackwell Publishing).
4. *Rock mechanics and the design of structures in rock*, L. Obert and Wilbur I. Duvall, (John Wiley & Sons, Inc.).

#### **Course Outcomes:**

At the end of this course, students will be able to

- CO1: Explain the mechanical and hydrological behavior of rock masses.
- CO2: Examine the strength of rock by different tests.
- CO3: Review the failure criteria of rock.
- CO4: Analyze in-situ stresses from field test data.
- CO5: Justify different remedial measures for rock failure.
- CO6: Interpret different procedures of excavation of tunnels.



Course code	PEC-CE 711(I)				
Category	Professional Elective Courses				
Course title	Ground Improvement Techniques				
Scheme and Credits	L	T	P	Credits	Semester-VII
	3	0	0	3	
Pre-requisites (if any)	Basic Soil Mechanics.				

### Theory Syllabus:

<b>Module</b>	<b>Course Content</b>	<b>Lecture/ Tutorial Period</b>
<b>1.</b>	<b>Introduction:</b> Need for Ground Improvement, Different types of problematic soils, Emerging trends in ground Improvement.	<b>2L</b>
<b>2.</b>	<b>Mechanical stabilization:</b> Shallow and deep compaction requirements, Principles and methods of soil compaction, Shallow compaction and methods. Properties of compacted soil and compaction control, Deep compaction and Vibratory methods, Dynamic compaction.	<b>6L</b>
<b>3.</b>	<b>Hydraulic modification:</b> Ground Improvement by drainage, Dewatering methods. Design of dewatering systems, Preloading, Vertical drains, design and construction methods.	<b>10L</b>
<b>4.</b>	<b>Modification by admixtures:</b> Cement stabilization and cement columns, Lime stabilization and lime columns. Stabilization using bitumen and emulsions, Stabilization using industrial wastes, Construction techniques and applications.	<b>10L</b>
<b>5.</b>	<b>Grouting:</b> Compaction grouting, jet grouting, different varieties of grout materials, grouting under difficult conditions.	<b>8L</b>
<b>6.</b>	<b>In situ soil treatment methods:</b> Soil nailing, rock anchoring, micro-piles, design methods, construction techniques. Case studies of ground improvement projects.	<b>6L</b>
	<b>Total</b>	<b>42L</b>
	<b>No. of Week Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

### Books: Text and/or Reference:

1. *Advanced Foundation Engineering by – V.N.S. Murthy (CBS Publishers).*

2. *Foundation Analysis & Design* by J.E. Bowels (Mc Graw Hill)
3. *Principles of Foundation Engineering* by B.M. Das (PWS Publishing)
4. *Theory and Practice of Foundation Design* by N. N. Som and S. C. Das (PHI Learning).
5. *Ground Improvement Techniques* by B.C. Chattopadhyay and J. Maity (PHI Learning).
6. *Construction and Geotechnical Methods in Foundation Engineering* by Koerner R.M. (McGraw-Hill).
7. *Ground Improvement Techniques* by Purushothama Raj, P. (Tata McGraw-Hill).

#### Course Outcomes:

At the end of this course, students will be able to

CO1: Recognize the existing characteristics of the soil to be improved.

CO2: Demonstrate different mechanism of ground improvement.

CO3: Plan for a suitable type of ground improvement technique for field soil.

CO4: Set up various ground improvement project work.

CO5: Judge the efficiency of ground improvement methods.

CO6: Employ the selected ground improvement methods at site.

Course code	PEC-CE711(m)				
Category	Professional Elective Courses				
Course title	Environmental Pollution Control Technology				
Scheme and Credits	L	T	P	Credits	Semester-VII
	3	1	0	3	
Pre-requisites (if any)	Environmental Engineering-I (PCC-CE 401) Environmental Engineering-II (PCC-CE 504)				

#### Theory Syllabus:

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	Introduction: Man, Environment and ecosystems – their inter-relationships, Types of environmental pollutants, Their sources and effects, Environmental impact assessment, Food Chain, Carbon Cycle, Nitrogen Cycle, Eco pond system	<b>10L+4T</b>
<b>2.</b>	Air pollution: Air Pollution Control Device, Plume dispersion Models, Legal aspects of air pollution control.	<b>10L+4T</b>

3.	Solid wastes: Container Hauling System Design, Transfer station, Processing, Disposal and reuse. Landfill Design, Incineration Design	10L+3T
4.	Noise pollution: Characteristics of sound and its measurement, Levels of noise, Important noise level parameters, Noise control measures, Standards of noise levels for different cases.	12L+3T
	<b>Total</b>	<b>42L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

Books: Text and/or Reference:

1. Iqbal Khan, "Solid Waste Management".
2. R Kant and K Kant, "Air Pollution and Control", Khanna Publishing House.
3. K Wark, CF Warner and WT Davis, "Air Pollution: Its Origin and Control".
4. SK Agarwal, "Noise Pollution".
5. DP Tripathy, "Noise Pollution".

#### Course Outcomes:

At the end of this course, students will be able to

CO1. Understand the importance of human environment relationship and the types of environmental pollutants with their sources and effects.

CO2. Describe control devices and dispersion models of air pollution and legal aspects of pollution control.

CO3. Illustrate solid waste processing, disposal and reuse with design of landfill, incineration etc.

CO4. Explain the characteristics and measurement of sound with level and control measures of noise.

Course code	PEC-CE711(n)				
Category	Professional Elective Courses				
Course title	Air and Noise Pollution and Control				
Scheme and Credits	L	T	P	Credits	Semester-VII
	3	1	0	3	
Pre-requisites (if any)	Environmental Engineering-I (PCC-CE 401)				

#### Theory Syllabus:

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
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1.	Air pollution: composition and structure of atmosphere, global implications of air pollution. Classification of air pollutants: particulates, hydrocarbon, carbon monoxide, oxides of sulphur, oxides of nitrogen and photo chemical oxidants. Indoor air pollution, Effects of air pollutants on humans, animals, property and plants.	6L+2T
2.	Air pollution chemistry, meteorological aspects of air pollution dispersion; temperature lapse rate and stability, wind velocity and turbulence, plume behaviour, dispersion of air pollutants, the Gaussian Plume Model, stack height and dispersion.	8L+3T
3.	Ambient air quality and standards, air sampling and measurements; Ambient air sampling, collection of gaseous air pollutants, collection of particulate air pollutants, stack sampling. Control devices for particulate contaminants: gravitational settling chambers, cyclone separators, wet collectors, fabric filters (Bag-house filter), electrostatic precipitators (ESP).	10L+3T
4.	Control of gaseous contaminants: Absorption, Adsorption, Condensation and Combustion Control of sulphur oxides, nitrogen oxides, carbon monoxide, and hydro carbons. Automotive emission control, catalytic convertor, Euro-I, Euro-II and Euro-III specifications, Indian specifications.	8L+3T
5.	Noise pollution: Basics of acoustics and specification of sound; sound power, sound intensity and sound pressure levels; plane, point and line sources, multiple sources; outdoor and indoor noise propagation; psycho-acoustics and noise criteria, effects of noise on health, annoyance rating schemes; special noise environments: Infra-sound, ultrasound, impulsive sound and sonic boom; noise standards and limit values; noise instrumentation and monitoring procedure. Noise indices.	10L+3T
	<b>Total</b>	<b>42L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

*Books: Text and/or Reference:*

1. Peavy, Rowe and Tchobanoglous, "Environmental Engineering".
2. Martin Crawford, "Air Pollution Control Theory".
3. K Wark, CF Warner and WT Davis, "Air Pollution: Its Origin and Control
4. Rao and Rao, "Air Pollution Control Engineering".
5. K Kant and R Kant, "Air Pollution and Control Engineering", Khanna Publishing House.
6. CS Rao, "Environmental Pollution Control Engineering", Wiley Eastern Ltd.
7. CS Rao, "Air pollution and control"
8. PF Cunniff, "Environmental Noise Pollution", McGraw Hill.
9. ND Nevers, "Air Pollution Control Engineering".
10. MP Poonia and SC Sharma, "Environmental Engineering, Khanna Publishing House.
11. OP Gupta, "Elements of Environmental Pollution Control", Khanna Publishing House.

**Course Outcomes:**

At the end of this course, students will be able to

CO1. Understand the classifications and effects of air pollutants with global implications of air pollution.

CO2. Demonstrate the air pollution due to industries & automobile exhausts with chemistry, meteorological aspects and dispersion of air pollutants.

CO3. Understand the air quality and emission standards and air sampling and measurements with control devices for particulate contaminants of air pollution.

CO4. Describe the control of gaseous contaminants and automotive emission control specification.

CO5. Understand noise pollution, specification, power and propagation of sound, effects on health, standards and limit values.

**Detail Syllabus  
(Semester – VIII)**

Course code	PCC-CE 851				
Category	Professional Core Course (PCC)				
Course title	Computer Application in Civil Engineering-II				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	0	0	2	1	
Pre-requisites (if any)	NA				

### Laboratory Syllabus:

1. Hands on experience of road design through different commercial softwares (OPEN ROAD Technology)
2. Hands on Experience of scheduling of different Projects by using different project management softwares. (PRIMAVERA)

### Course Outcome:

At the end of this course, students will be able to

**CO1:** design geometric feature of the road using available commercial software

**CO2:** design other cross-sectional feature of the road

**CO3:** manage civil construction project using different commercial software like PRIMAVERA

Course code	PCC-CE 891				
Category	Project				
Course title	Project-II				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	0	5	0	5	
Pre-requisites (if any)	NA				

- This is a new Project started at Semester-VIII.
- The full Marks of the Project – II is 100 and the credit point is 5.
- Each project group should complete their project in this Semester and finally prepare a comprehensive Project Report. Each group should submit at least three extra copy of Project Report other than their individual copy, one for their Project guide, one for the departmental library and one for Institute's main library.

- Project work and Project report of each project group should be demonstrated and presented in front of Board of Experts and evaluation will be made on that.
- This project should preferably be from the area of Electives taken.

Course code	PCC-CE 892				
Category	Project				
Course title	Seminar				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	0	0	4	2	
Pre-requisites (if any)	NA				

- Each student have to give 10 minutes' individual presentation / lecture on any topic (advanced technology, research or development, new emerging Field etc.) followed by 5 minutes interaction / discussion session.
- The presentation should be in front of teachers, students of the class.
- Marks will be given based on evaluation throughout the year and a final evaluation at the end of Semester based on a final presentation.
- Evaluation should be based on the following parameters of the students: Presentation skill, Delivery of the speech, Depth and breadth of the subject matter presented.
- The attendance of other students in the seminar will be recorded and their participation should also be assessed for evaluation of their participations.
- Each student has to submit a technical report for each presentation they have delivered.



**Appendix-III**  
**Professional Elective Courses (PEC) for 8<sup>th</sup> Semester**

Course code	PEC-CE 811(a)				
Category	Professional Elective Courses				
Course title	Advanced Foundation Engineering				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	2	1	0	3	
Pre-requisites (if any)	Basic Soil Mechanics, Foundation Engineering.				

**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture/ Tutorial Period</b>
<b>1.</b>	<b>Pile Foundations:</b> Estimation of load carrying capacity of single and pile group, Design of single pile and pile group, Settlement of pile foundation, Pile load testing . <b>Under reamed pile:</b> Identification of expansive soil, Design of under reamed pile.	<b>6L+2T</b>
<b>2.</b>	<b>Well foundation:</b> Its elements, size and depth, Forces on well foundation, Methods of sinking, scour depth, analysis of well foundation for bearing capacity and lateral stability.	<b>6L+2T</b>
<b>3.</b>	<b>Braced excavation:</b> types of bracing system, stability considerations, Strut load, Dewatering.	<b>5L+1T</b>
<b>4.</b>	<b>Ground improvement techniques:</b> Soil stabilization, Ground Improvement by drainage, Preloading, Vertical drains, design and construction methods. Grouting, Reinforced earth.	<b>10L</b>
<b>5.</b>	<b>Machine Foundation:</b> Types of machine and suitable foundations, General criteria for design of machine foundation, Resonance and frequency ratio, Soil dynamic parameters, Block type machine foundation, Principles of design of Foundations for reciprocating as per IS code.	<b>8L+2T</b>
	<b>Total</b>	<b>35L+7T</b>
	<b>No. of Week Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

**Books: Text and/or Reference:**

*1. Principles of Soil Mechanics & Foundation Engineering by – V.N.S. Murthy (UBS Publishers).*

2. *Soil Mechanics & Foundation Engineering* by – B.C. Punmia (Laxmi Publications).
3. *Advanced Foundation Engineering* by – V.N.S. Murthy (CBS Publishers).
4. *Foundation Analysis & Design* by J.E. Bowels (Mc Graw Hill)
5. *Principles of Foundation Engineering* by B.M. Das (PWS Publishing)
6. *Theory and Practice of Foundation Design* by N. N. Som and S. C. Das (PHI Learning).
7. *Ground Improvement Techniques* by B.C. Chattopadhyay and J. Maity (PHI Learning).
8. *Ground Improvement Techniques* by Purushothama Raj, P. (Tata McGraw-Hill).
9. *Analysis and Design of Substructures* by Swami Saran (Oxford and IBH Pub.).
10. *Soil Dynamics and Machine Foundation* by Swami Saran (Galgotia Publication).

#### Course Outcomes:

At the end of this course, students will be able to

CO1: Design appropriate deep foundation for a heavy structure.

CO2: Analyze well foundation for bridge piers against different loads.

CO3: Design proper strut for braced excavation.

CO4: Execute ground improvement work by stabilization of soil.

CO5: Apply different drainage techniques to improve the ground soil.

CO6: Design machine foundation considering dynamic properties of soil.

Course code	PEC-CE 811(b)				
Category	Professional Elective Courses				
Course title	Dynamics of Soil and Foundation				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	2	1	0	3	
Pre-requisites (if any)	Basic Soil Mechanics, Foundation Engineering.				

#### Theory Syllabus:

<b>Module</b>	<b>Course Content</b>	<b>Lecture/ Tutorial Period</b>
<b>1.</b>	<b>Fundamental of vibrations:</b> Degrees of freedom, Natural frequency, Undamped single degree freedom system, Damped single degree freedom system,	<b>8L+2T</b>

	Transmissibility, Response to ground motion, Introduction to multiple degree freedom system.	
2.	<b>Dynamic properties of Soil:</b> Laboratory and field evaluation of soil properties as per IS codes, Elastic constants of soils, Correlations for shear modulus and damping ratio in sand, gravels, clays.	8L
3.	<b>Propagation of elastic waves in soils:</b> Mechanism of wave propagation, Body waves, Surface waves, Rayleigh waves.	6L
4.	<b>Liquefaction of soils:</b> Definition, Causes and effects of Liquefaction, Evaluation of Liquefaction potential, Mitigation of Liquefaction Hazards	6L
5.	<b>Analysis and design of Block type Machine Foundation:</b> Types of Machine Foundations, General requirement of Machine foundations, Dimensional criteria, Methods of Dynamic Analysis, Design considerations for dynamically loaded foundations and constructional features; Machine Foundations Design.	10L+2T
	<b>Total</b>	<b>38L+4T</b>
	<b>No. of Week Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

#### Books: Text and/or Reference:

1. *Structural Dynamics* by Mario Paz (CBS Publishers).
2. *Fundamentals of Soil Dynamics and Earthquake Engineering* by B B Prasad, (PHI learning).
3. *Advanced Foundation Engineering* by –V.N.S. Murthy (CBS Publishers).
4. *Foundation Analysis & Design* by J.E. Bowels ( Mc Graw Hill)
5. *Principles of Foundation Engineering* by B.M. Das (PWS Publishing)
6. *Theory and Practice of Foundation Design* by N. N. Som and S. C. Das (PHI Learning).
7. *Soil Dynamics and Machine Foundation* by Swami Saran (Galgotia Publication).
8. *Soil Dynamics and Liquefaction* by A. S. Cakmak, (Elsevier Computational Mechanics Publication).
9. *Soil Dynamics* by Shamsher Prakash (McGraw Hill).

#### Course Outcomes:

At the end of this course, students will be able to

- CO1: Understand fundamental of vibration for damped and undamped single degree of freedom system.
- CO2: Recognize the scope and significance of soil dynamics.
- CO3: Evaluate dynamic soil properties by laboratory and field test.
- CO4: Understand the mechanism of wave propagation in soil.
- CO5: Predict the liquefaction problem and suggest remedial measures.
- CO6: Employ the code of practice for design of foundations for reciprocating machines.

Course code	PEC-CE 811(c)				
Category	Professional Elective Courses				
Course title	Sub-structure Design				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	2	1	0	3	
Pre-requisites (if any)	Basic Soil Mechanics, Foundation Engineering.				

**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture/ Tutorial Period</b>
<b>1.</b>	<b>Shallow Foundations:</b> Bearing capacity according to BIS, Types of shallow foundations, Settlement of Shallow Foundations: Immediate, consolidation and differential settlements. Principles of design of footing, Proportioning of footings for equal settlement. Design of isolated footing, combined footing, Strap footing, Strip footing and Raft (Proportioning only).	<b>9L+1T</b>
<b>2.</b>	<b>Pile Foundations:</b> Necessity of pile foundations, Classification, Load bearing capacity of single pile by Static formula, Dynamic formula, Pile load test and Penetration tests. Pile groups, group action of piles in sand and clay, group efficiency of piles, settlement of piles, negative skin friction, Under reamed piles.	<b>7L+1T</b>
<b>3.</b>	<b>Well Foundations:</b> Introduction, Different shapes and characteristics of wells. Components of well foundation. Forces acting on well foundation. Sinking of wells. Causes and remedies of tilts and shifts.	<b>7L+1T</b>
<b>4.</b>	<b>Drilled Piers and Caissons:</b> Introduction, construction, advantages and disadvantages of drilled piers. Design of open, pneumatic and floating caissons. Advantages and disadvantages of floating caissons.	<b>5L+1T</b>
<b>5.</b>	<b>Machine Foundations:</b> Introduction, Types of Machine foundations, basic definitions, degree of freedom of a block foundation, general criteria for design of machine foundation, free and forced vibrations, vibration analysis of a machine foundation, determination of natural frequency, vibration isolation and control.	<b>9L+1T</b>
	<b>Total</b>	<b>37L+1T</b>
	<b>No. of Week Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

**Books: Text and/or Reference:**

1. *Principles of Soil Mechanics & Foundation Engineering* by – V.N.S. Murthy (UBS Publishers).
2. *Soil Mechanics & Foundation Engineering* by – B.C. Punmia (Laxmi Publications).
3. *Advanced Foundation Engineering* by – V.N.S. Murthy (CBS Publishers).
4. *Foundation Analysis & Design* by J.E. Bowels ( Mc Graw Hill)
5. *Principles of Foundation Engineering* by B.M. Das (PWS Publishing)
6. *Theory and Practice of Foundation Design* by N. N. Som and S. C. Das (PHI Learning).
7. *Analysis and Design of Substructures* by Swami Saran (Oxford and IBH Pub.).
8. *Soil Dynamics and Machine Foundation* by Swami Saran (Galgotia Publication).

**Course Outcomes:**

At the end of this course, students will be able to

CO1: Choose a type of shallow foundation a structure according to load and sub-soil properties.

CO2: Evaluate allowable bearing capacity of different shallow foundation.

CO3: Evaluate pile capacity from field test and analytical formulations.

CO4: Design a pile group required for a structure.

CO5: Analyze well foundation for bridge piers against different loads.

CO6: Design foundation for reciprocating machines as per IS code recommendations.

Course code	PEC-CE811(d)				
Category	Professional Elective Courses				
Course title	Traffic Engineering and Management				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	2	1	0	3	
Pre-requisites (if any)	Transportation Engineering				

**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	<b>Traffic Engineering &amp; its elements:</b> Introduction, Objectives and Scope of Traffic Engineering; Components of Road Traffic – vehicle, Driver and Road; Road User and Vehicle Characteristics and their effect on Road Traffic; Traffic Maneuvers. Traffic	<b>8L+4T</b>

	<p>Stream Characteristics- Relationship between Speed, Flow and Density</p> <p><b>Traffic Measurement and Analysis:</b> Volume Studies - Objectives, Methods, Speed studies - Objectives: Definition of Spot Speed, time mean speed and space mean speed, Methods of conducting speed studies. Presentation of speed study data; Headways and Gaps, Critical Gap, Gap acceptance studies.</p> <p><b>Traffic Flow Theory:</b> Fundamental flow relationship and their applications, Traffic flow theories and applications; Shock waves; Queuing theory and applications.</p>	
2	<p><b>Highway Capacity And Level Of Service:</b> Basic definitions related to capacity, Level of service concept, Factors affecting capacity and level of service, Computation of capacity and level of service for two lane highways, Multilane highways and freeways.</p>	4L+2T
3	<p><b>Traffic Control And Regulation:</b> Traffic Signals - Design of Isolated Traffic Signal by Webster method, Warrants for signalization, Signal Co-ordination methods, Simultaneous, Alternate, Simple progression and Flexible progression Systems.</p>	4L+2T
4	<p><b>At-grade intersections:</b> sight distance considerations and principles of design, channelization, mini roundabouts, layout of roundabouts. Advantages and limitations of roundabouts.</p> <p><b>Rotary Intersections:</b> Definitions – Diverging, Merging, Weaving, Weaving Length, Advantages and Disadvantages. Rotary Design Elements – Design Speed, Radius at Entry, Radius at Exit, Width of Rotary Carriage way, Entry and Exit angles, External kerb line, Super elevation and camber- Capacity of rotary.</p>	4L+2T
5	<p><b>Interchanges</b> – Advantages and Disadvantages, Major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes, bicycle and pedestrian facility design.</p>	2L+1T
6	<p><b>Parking Studies and Analysis:</b> Types of parking facilities - on street parking and off street Parking facilities, Parking studies and analysis.</p> <p><b>Traffic Safety:</b> Analysis of individual accidents and statistical data; Methods of representing accident rate; Factors in traffic accidents; influence of roadway and traffic conditions on traffic safety; accident coefficients; Engineering, Enforcement and Education measures for the prevention of accidents.</p>	4L+2T
7	<p><b>Traffic Management:</b> Transportation System Management – Travel Demand management –Traffic Management measures – Purpose, Measures – Types of traffic management measures – Restriction of Turning Movements – One - way streets – Tidal Flow operations – Closing Side Streets – Exclusive Bus Lanes.</p>	2L+1T
	<b>Total</b>	<b>28L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of weeks in hand</b>	<b>2</b>

**Text Books:**

1. *Traffic Engineering and Transportation Planning* - L.R. Kadiyali, Khanna Publishers.
2. *Highway Engineering*, S.K. Khanna and C.E.G Justo and A. Veeraragavan, Nemchand Brothers publications.
3. *Transportation Engineering - An introduction* - C. Jotin Khistry, Prentice Hall Publication.
4. *Fundamentals of Transportation Engineering* - C.S.Papacostas, Prentice Hall India

**Reference Books**

1. *Traffic Engineering - Theory & Practice* - Louis J. Pignataro, Prentice Hall Publication.
2. *Principles of Highways Engineering and Traffic Analysis* - Fred Mannering & Walter P. Kilareski, John Wiley & Sons Publication.
3. *Principles of Transportation Engineering*, Partha Chakraborty and Animesh Das, PHI Learning.

**Course Outcomes:**

At the end of this course, students will be able to

- CO1:** Estimate basic characteristics of traffic stream.
- CO2:** Conduct traffic studies and analyze traffic data.
- CO3:** Design traffic signal systems.
- CO4:** Determine the capacity of highways.
- CO5:** Design parking facility.
- CO6:** Carry out road accident safety analysis.

Course code	PEC-CE811(e)			
Category	Professional Elective Courses			
Course title	Pavement Design			
Scheme and Credits	L	T	P	Semester – VIII
	2	1	0	
Pre-requisites (if any)	Basic Soil Mechanics, Transportation Engineering			

**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	<p><b>Introduction:</b> Types and component parts of pavements, Factors affecting design and performance of pavements. Functions of sub-grade, sub base, Base course, surface course, comparison between Rigid and flexible pavement.</p> <p><b>Pavement Material Characterization:</b> Identification of different type of materials Field and laboratory methods for characterization of pavement materials.</p>	<b>2L+1T</b>

2	<b>Stresses and deflections in Flexible Pavements:</b> Stresses and deflections in homogeneous masses. Burmister's two layer theory, three layer and multi-layer theories; wheel load stresses, various factors in traffic wheel loads; ESWL of multiple wheels. Repeated loads and EWL factors; sustained loads. Pavement behavior under transient traffic loads.	6L+2T
3	<b>Flexible Pavement Design Methods For Highways:</b> Empirical, semi-empirical and theoretical approaches, development, principle, design steps, advantages; design of flexible pavements as per IRC; Design of low volume flexible road as per IRC	6L+3T
4	<b>Stresses in Rigid Pavements:</b> Types of stresses and causes, factors influencing the stresses; general considerations in rigid pavement analysis, EWL; wheel load stresses, warping stresses, frictional stresses, combined stresses.	4L+2T
5	<b>Rigid Pavement Design:</b> Types of joints in cement concrete pavements and their functions, joint's spacing; design of CC pavement for roads and runways as per IRC, design of joint details for longitudinal joints, contraction joints and expansion joints. IRC method of design by stress ratio method. Design of continuously reinforced concrete pavements; Design of Cement Concrete pavement for low volume Road as per IRC.	6L+2T
6	<b>Pavement Overlay Designs:</b> Types of failures and causes in flexible and rigid pavements. Maintenance, repair and rehabilitation of pavements including design of bituminous and concrete overlays as per IRC.	2L+2T
7	<b>Structural Design of Airport Pavements -</b> Design factors for Runway Pavements, Design methods for Airfield pavements.	2L+2T
	<b>Total</b>	<b>28L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of weeks in hand</b>	<b>2</b>

**Text/reference Books:**

1. *Highway Engineering*, S.K. Khanna and C.E.G Justo and A. Veeraragavan, Nemchand Brothers publications.
2. *Pavement Analysis and Design* by Y. H. Huang, PHI
3. *Principles of Pavement Design* by E.J.Yoder and M.W. Witczak, Wiley
4. *R Srinivasa*
5. *IRC: 37-2018 Guidelines for the Design of Flexible Pavements*, The Indian Roads Congress, New Delhi, India, 2012.
6. *IRC: 58-2015 Guidelines for the Design of Plain Jointed Rigid Pavements for Highways*, The Indian Roads Congress, New Delhi, India, 2011.



7. IRC: SP: 62-2014 Guidelines for the Design and Construction of Cement Concrete Pavements for Rural Roads, The Indian Roads Congress, New Delhi, India, 2004.
8. IRC: SP: 72-2015 Guidelines for the Design of Flexible Pavements for Low Volume Rural Roads, The Indian Roads Congress, New Delhi, India, 2007.
9. Pavement Engineering – Principles and Practice, Mallick, R.B. and T. El-Korchi, CRC Press, Taylor and Francis Group, Florida, USA, 2009.
10. Ministry of Road Transport and Highways. Specifications for Road and Bridge Works, Fifth Edition, Indian Roads Congress, New Delhi, India, 2013.

### Course Outcomes:

At the end of this course, students will be able to

**CO1:** Characterize the materials used in pavement construction.

**CO2:** Analyze and design flexible pavement.

**CO3:** Analyze and design rigid pavement.

**CO4:** Identifies cause of failures in flexible pavement and do the maintenance and rehabilitation work.

**CO5:** Identifies cause of failures in rigid pavement and do the maintenance and rehabilitation work.

**CO6:** Analyze and design the airfield pavement.

Course code	PEC-CE811(f)			
Category	Professional Elective Courses			
Course title	Pavement Materials			
Scheme and Credits	L	T	P	Semester – VIII
	3	0	0	
Pre-requisites (if any)	Transportation Engineering			

### Theory Syllabus:

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	<b>Sub-grade Soil Characterization:</b> Soil Classification; Index & Engineering properties of soil, Properties of sub-grade; Mechanical response of soil; A critical look at the different laboratory and in-situ procedures for evaluating the mechanical properties of soils viz CBR, Plate Load test, resilient modulus, DCPT,	<b>8</b>

	<p>Suitability of different type of soil for the construction of highway embankments and pavement layers; Field compaction and control.</p> <p><b>Introduction to Soil Stabilization:</b> Physical and Chemical modification: Stabilization with admixtures like cement, lime, calcium chloride, fly ash and bitumen</p>	
2	<p><b>Aggregate Characterization:</b> Origin, Classification, Types of aggregates; Sampling of aggregates; Mechanical and shape properties of aggregates, Aggregate texture and skid resistance, polishing of aggregates; Proportioning and Blending of aggregates: Super pave gradation, Fuller and Thompson's Equation, 0.45 power maximum density graph; Use of locally available materials in lieu of aggregates.</p>	8
3	<p><b>Bitumen Characterization:</b> sources, Composition of bitumen, Rheology of bitumen, types of bituminous material, properties of bitumen.</p> <p><b>Properties of Bituminous Mixes:</b> Elastic modulus, Dynamic modulus; stiffness modulus using shell nomographs; visco-elastic and fatigue, creep test; Resilient modulus, Complex (Dynamic) Moduli of Bituminous Mixes.</p> <p><b>Modified bitumen:</b> Crumb Rubber Modified bitumen, Natural rubber modified bitumen, polymer modified bitumen; Long term and short term ageing and its effect on bitumen performance, Tests to simulate ageing of bitumen viz. RTFO and PAV.</p> <p><b>Design of bituminous mixes:</b> Marshall's specifications; Introduction to super pave mix design procedure</p>	12
4	<p><b>Cement and Cement Concrete Mix Characterization:</b> Types of cements and basic properties; Quality tests on cement; Tests on cement concrete including compressive strength, flexural strength, modulus of elasticity and fatigue properties.</p>	8
5	<p><b>Reclaimed/Recycled Waste Products:</b> Reclaimed Materials; waste products in highway projects: applications; effect of waste products on materials, structure and properties; self-healing and smart materials; locally available materials.</p>	6
<b>Total</b>		<b>42L</b>
<b>No. of Weeks Required</b>		<b>14</b>
<b>No. of weeks in hand</b>		<b>2</b>

**Text Books:**

1. *Principles of Transportation Engineering*, A. Das, and P. Chakroborty, 1st Edition, PHI Publication.

**Reference books:**

1. Atkins, N. Harold, *Highway Materials, Soils and Concretes, Fourth Edition, 2002, Prentice-Hall.*
2. Kerbs Robert D. and Richard D. Walker, *Highway Materials, McGraw-Hill, 1971.*
3. *Alternative Materials in Road Construction, P. T. Sherwood, Thomas Telford Publication*
4. *Relevant IRC and IS Codes of Practices (Separate List will be given).*

**Course Outcomes:**

At the end of this course, students will be able to

**CO1:** Characterize subgrade soil to do soil treatment of weak subgrade soil.

**CO2:** Characterize road aggregates and prepare different graduation requirement for bituminous mix.

**CO3:** Characterize paving grade bitumen.

**CO4:** to design bituminous mixes.

**CO5:** to design concrete mix for rigid pavement.

**CO6:** to reclaim bitumen and aggregate from pavement and design it for reuse.

Course code	PEC-CE811(g)				
Category	Professional Elective Courses				
Course title	Urban Transportation System Planning				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	2	1	0	3	
Pre-requisites (if any)	None				

**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	<p><b>Introduction:</b> Transport and Socioeconomic Activities; Historical development of Transport; Transportation in the Cities; Freight Transportation; Future Developments.</p> <p><b>Conceptual Aspects:</b> Transport Planning Process, Problem Definition, Solution Generation, Solution Analysis, Evaluation and Choice, Implementation; Sequence of Activities Involved in Transportation analysis</p>	<b>6L+2T</b>

2	<b>Trip Generation Analysis:</b> Trip Generation Models- Zonal Models, Category analysis, Household Models, Trip Attractions of Work Centres & Commercial Trips.	4L+2T
3	<b>Trip Distribution Analysis:</b> Presentation of Trip-Distribution Data, PA Matrix to OD Matrix, Basis of Trip Distribution, Gravity Model of Trip Distribution, Calibration of Gravity Model, Singly and Doubly Constrained, Gravity Models, Case Studies. Growth Factor Methods of Trip Distribution, Uniform Factor Method, Average Factor Method, Fratar Growth-Factor Method, Disadvantage of Growth Factor	4L+4T
4	<b>Mode Choice Modelling:</b> Influencing Factors, Earlier Modal Split Models, Trip-End Type Modal Split Model, Trip-Interchange Modal Split Model, Disaggregate Mode-Choice Model, Logit Model of Mode-Choice, Binary Choice Situations, Multinomial Logit Model, Model Calibration, Case Studies.	4L+2T
5	<b>Route Assignment:</b> Description of Transport Network, Route Choice Behaviour, The Minimum Path, Minimum Path Algorithm, Route Assignment Techniques, All-or-nothing Assignment, Multipath Traffic Assignment, Capacity-Restrained Traffic Assignment.	4L+2T
6	<b>Transportation Survey:</b> Definition of Study Area Zoning, Types of movements ,Types of Surveys, Home-Interview Survey, Commercial Vehicle Survey, Intermediate Public Transport Survey, Cordon-Line Survey, Post-Card Questionnaire Survey, Registration-Number Survey, Tag-on-Vehicle Survey.	3L+1T
7	<b>Transport Related Land-use Models:</b> Development of Land-use Models, The Lowry Model, Application of Lowry Model. Quick response techniques. Characteristics of urban structure. Town planning concepts.	3L+1T
	<b>Total</b>	<b>28L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of weeks in hand</b>	<b>2</b>

**Text / Reference Books:**

1. Hutchinson, B.G., *Principles of Urban Transportation System Planning*, Mc-Graw Hill 1974.
2. Khisty, C J., *Transportation Engineering – An Introduction*, Prentice-Hall, NJ, 2007
3. Dickey, J.W., *Metropolitan Transportation Planning*, Tata Mc-Graw Hill, 1980
4. Meyer, Michael D, *ITE Transportation Planning Handbook*, John Wiley & Sons 2016
5. Kanafani, A., *Transportation Demand Analysis*, McGraw-Hill, 1983.

6. *Oppenheim, N., Applied Models in Urban and Regional Analysis, Prentice-Hall, NJ, 1995.*
7. *Bruton M.J., Introduction to Transportation Planning, Hutchinson of London, 1970.*
8. *Gallion A.B and Eisner S., The Urban Pattern, Affiliated East-West Press, New Delhi, 1993.*
9. *Meyer M.D. and Miller E.J., Urban Transportation Planning, McGraw-Hill International, 2001*
10. *Ortuzar J D & Willumsen L G, Modelling Transport, John Wiley & Sons Ltd, 2001.*
11. *Ennio Cascetta, Transportation Systems Analysis, Springer, 2009*

### Course Outcomes

At the end of this course, students will be able to

**CO1:** Design and administer surveys to provide the data required for transportation planning.

**CO2:** Estimate travel demand generation at aggregate and disaggregate levels

**CO3:** Determine travel demand distribution using gravity models and growth factor methods.

**CO4:** Identify the factors of travel mode choice and develop modal split models.

**CO5:** Compute the shortest path and assign the travel demand

**CO6:** Estimate the traffic impact of new developments using the four-stage sequential models.

**CO7:** Develop land use integrated travel demand models.

Course code	PEC-CE811(h)				
Category	Professional Elective Courses				
Course title	Sustainable Engineering & Technology				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	1	0	3	
Pre-requisites (if any)	Environmental Engineering-I (PCC-CE 401)				

### Theory Syllabus:

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	Sustainability - Introduction, Need and concept of sustainability, Social-environmental and economic sustainability concepts. Sustainable development, Nexus between Technology and Sustainable development, Challenges for Sustainable Development. Multilateral environmental agreements and Protocols - Clean Development Mechanism (CDM), Environmental legislations in India - Water Act, Air Act.	<b>3L+2T</b>
<b>2.</b>	Air Pollution, Effects of Air Pollution; Water pollution- sources, Sustainable wastewater treatment, Solid waste - sources, impacts of solid waste, Zero waste	<b>6L+3T</b>

	concept, 3 R concept. Global environmental issues- Resource degradation, Climate change, Global warming, Ozone layer depletion, Regional and Local Environmental Issues. Carbon credits and carbon trading, carbon foot print.	
3.	Environmental management standards, ISO 14000 series, Life Cycle Analysis (LCA) - Scope and Goal, Bio-mimicking, Environment Impact Assessment (EIA) - Procedures of EIA in India.	4L+2T
4.	Basic concepts of sustainable habitat, Green buildings, green materials for building construction, material selection for sustainable design, green building certification, Methods for increasing energy efficiency of buildings. Sustainable cities, Sustainable transport.	5L+2T
5.	Energy sources: Basic Concepts-Conventional and non-conventional, solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans, Geothermal energy.	5L+2T
6.	Green Engineering, Sustainable Urbanisation, industrialisation and poverty reduction; Social and technological change, Industrial Processes: Material selection, Pollution Prevention, Industrial Ecology, Industrial symbiosis.	5L+3T
	<b>Total</b>	<b>42L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

Books: Text and/or Reference:

1. DT Allen and DR Shonnard, "Sustainability Engineering: Concepts, Design and Case Studies", Prentice Hall.
2. AS Bradley, AO Adebayo and P Maria, "Engineering applications in sustainable design and development", Cengage learning
3. KM Mackenthun, "Basic Concepts in Environmental Management", Lewis Publication.
4. NB Chang, "Systems Analysis for Sustainable Engineering: Theory and Applications", McGraw-Hill Professional.
5. JW Twidell and AD Weir, "Renewable Energy Resources", English Language Book Society (ELBS).
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006
7. ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications- Rating System, TERI Publications - GRIHA Rating System
8. SS Purohit, "Green Technology - An approach for sustainable environment", Agrobios publication

### Course Outcomes:

At the end of this course, students will be able to

- CO1. Establish a clear understanding of the role and impact of various aspects of engineering and engineering decisions on environmental, societal, and economic problems.
- CO2. Understand different types of environmental pollution problems and their sustainable solutions.
- CO3. Understand environmental management standards and the role of engineering and technology within sustainable development.
- CO4. Know the methods, tools, and incentives for sustainable product-service system development.

CO5. Identify energy sources for Sustainable Urbanization.

Course code	PEC-CE811 (i)				
Category	Professional Elective Course (PEC)				
Course title	Pre-Stressed concrete				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	2	1	0	3	
Pre-requisites (if any)	Structural Mechanics (ESC-CE 401), Structural Analysis-I (PCC-CE505)				

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	<b>Introduction:</b> Basic concept of prestressing Classification and Types of Prestressed Concrete Structures, advantages of prestressed concrete, application of prestressed concrete, Prestressed Concrete versus Reinforced Concrete	<b>4L+1T</b>
<b>2</b>	<b>Analysis of prestress and bending stresses:</b> Basic assumption, resultant stresses at a section, pressure line, concept of load balancing, cracking moment.	<b>4L+1T</b>
<b>3</b>	<b>Prestress Losses:</b> Total Losses in Pretensioned Members, Total Losses in Post-Tensioned Members, Methods for Estimating Prestress Losses, Elastic Shortening, Relaxation, Shrinkage, Creep, Friction, Anchorage Slip	<b>6L+2T</b>
<b>4</b>	<b>Deflections of prestressed concrete member:</b> Background Information, Short-Term Deflections, Long-Term Deflections (Simplified Method), Long-Term Deflections (Incremental Time-Step Method), Deflection Limitations, Deflection Control.	<b>4L+1T</b>
<b>5</b>	<b>Flexural strength of prestressed concrete sections:</b> Types of flexural failure, strain compatibility method, Indian code provisions	<b>4L+1T</b>
<b>6</b>	<b>Design of prestressed concrete sections:</b> design for flexure, minimum section modulus and prestressing force, magnel's graphical solution.	<b>6L+2T</b>
<b>7</b>	<b>Design for shear and torsion:</b> shear and principal stresses, ultimate shear resistance of prestressed concrete member, design of shear reinforcements, prestressed concrete member in torsion, design of reinforcements for torsion, shear and bending	<b>6L+2T</b>

<b>8</b>	<b>Continuous Pre-stressed Beams:</b> Background Information, Secondary, Moments and Zero-Load C Line, Linear Transformation, Properties of Concordant Tendons, Equivalent Loads.	<b>8L+4T</b>
	<b>Total</b>	<b>42L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

**Text/Reference Books:**

1. Rajagopalan.N, “Prestressed Concrete”, Narosa Publishing House, 2002.
2. Dayaratnam.P., “Prestressed Concrete Structures”, Oxford and IBH, 2013
3. Lin T.Y. and Ned.H.Burns, “Design of prestressed Concrete Structures”, Third Edition, Wiley India Pvt. Ltd., New Delhi, 2013.
4. IS1343:1980, Code of Practice for Prestressed Concrete, Bureau of Indian Standards, New Delhi, 2012
5. Krishna Raju N., “Prestressed concrete”, 5th Edition, Tata McGraw Hill Company, New Delhi, 2012
6. Pandit.G.S. and Gupta.S.P., “Prestressed Concrete”, CBS Publishers and Distributors Pvt. Ltd, 2012.

**Course Outcomes:**

On completion of the course students will be able to

CO1: Employ the concept of pre-tensioning and post-tensioning beam.

CO2: Analyze Pre-stressed concrete structures.

CO3: Evaluate different types of losses in pre-stressed concrete beam.

CO4: Compute deflection of pre-stressed concrete beam.

CO5: Design of Pre-stressed concrete beam section.

CO6: Analyze of continuous pre-stressed beam structures.

Course code	PEC-CE811(j)				
Category	Professional Elective Courses				
Course title	Advanced Structural Design				
Scheme and Credits		T	P	Credits	Semester – VIII
		1	0	3	
Pre-requisites (if any)	Design of Concrete Structures, Design of Steel Structures,				



	<b>Structural Dynamics and Earthquake Resistance Structure, Structural Analysis-II</b>
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<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Design of RCC liquid storage structure</b> resting on ground (rectangular and circular), I.S code method. Design of dome structure and its detailing.	<b>12L+4T</b>
<b>2.</b>	<b>Fundamental concept on effect of lateral loads</b> due to wind and earthquake on building frame (as per IS 875 and 1893)	<b>10L+4T</b>
<b>3.</b>	<b>Plate girders</b> - Design of Webs & Flanges , Concepts of curtailment of flanges – Riveted & Welded Web stiffeners, Web Flange splices - Riveted, Welded& Bolted. <b>Gantry Girder-</b> Design gantry girder considering lateral buckling – I.S code provisions.	<b>12L+4T</b>
<b>4.</b>	<b>R.C.C.Bridges:</b> Different Types – IRC loading – General consideration IRC specification simple design of a solid slab bridge.	<b>8L+2T</b>
	<b>Total</b>	<b>42L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

#### **Text/Reference Books:**

1. *Relevant IS and IRC codes.*
2. *Fundamentals of Prestressed concrete – N.C. Sinha&S.K.Roy.*
3. *Design of Bridge Structures – Jagadish&Jayaram – Prentice Hall*
4. *Principle & Practice of Bridge Engineering – S.P. Bindra- DhanpatRai.*
5. *Prestressed Concrete-Ramamrutham.*
6. *Design Steel Structures- AryaAzmani – Nemchand Bros.*
7. *Design of Steel Structures- Duggal- Tata McGraw Hill*
8. *The Steel Skeleton Vol-II Baker, Horne &Heymean- ELBS*
9. *Plastic Design of Steel Frames – Beedle – Jhon Wiley & Sons.*
10. *Advanced Design in Structural Steel – Lothers – Prentice – Hall.*

#### **Course Outcomes:**

On completion of the course students will be able to:

**CO1:** design of RCC liquid storage structure resting on ground (rectangular and circular) as per I.S code provision.

**CO2:** design plat girder and gantry girder considering IS code provision.

**CO3:** Design and detailing of RCC spherical dome structure.

**CO4:** Gather the fundamental concept on effect of lateral loads due to wind and earthquake on building frame (as per IS 875 and 1893)

**CO5:** Understand different types of IRC loading, class of loading applicable at RCC and steel bridge and will also be able to design solid slab and floor bridge.

Course code	PEC-CE811 (k)				
Category	Professional Elective Course (PEC)				
Course title	Bridge engineering				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	2	1	0	3	
Pre-requisites (if any)	Structural Mechanics (ESC-CE 401), Structural Analysis-I (PCC-CE505)				

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	<b>Introduction to bridge structures:</b> Types, Uses, Advantages and limitation of various types. Site selection, Site investigation, Calculation of waterway, Afflux and other effects.	<b>6L+2T</b>
<b>2</b>	<b>Bridge loadings:</b> Indian Road Congress and Indian Railways Specifications, Different Types of IRC loading, General consideration IRC specification simple design of a solid slab bridge.	<b>10L+4T</b>
<b>4</b>	<b>Design of steel bridges:</b> Truss and plate girder types.	<b>6L+2T</b>
<b>5</b>	<b>Design of R.C.C. bridges:</b> Use of IS, Pigeaud's and other methods, Load distribution theories and applications to simply supported T-girder bridges.	<b>10L+3T</b>
<b>6</b>	<b>Bridge substructure:</b> Design considerations for piers and abutments and foundations of various types.	<b>10L+3T</b>
	<b>Total</b>	<b>42L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

#### **Text/Reference Books:**

1. Bridge Engineering by S. Ponnuswamy, Mcgraw hill
2. Essentials Of Bridge Engineering by D. Johnson Victor ,
3. Design Of Bridge Structures by T.R.Jagadeesh and M.A.Jayaram , PHI
4. Design of Concrete Bridges by Vazirani & Ratwani, Khanna Publishers, New Delhi, 1986.

5. Principles and Practice of Bridge Engineering by Bindra S P, Dhanpat Rai & sons, New Delhi, 1999.

### Course Outcomes:

On completion of the course students will be able to

CO1: Impart basic knowledge about bridge structures.

CO2: Use IRC standards and design criteria for bridge structures.

CO3: Design different types of reinforced concrete bridge structures.

CO4: Design steel bridges,

CO5: Design different substructures of bridge.

Course code	PEC-CE811(I)				
Category	Professional Elective Courses				
Course title	Design of Offshore Structures				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	1	0	3	
Pre-requisites (if any)					

### Theory Syllabus:

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
<b>1</b>	Introduction, Wind, Tides and Waves: Generation, Propagation, Deepwater and shallow water waves, Breaking of waves. Breakwaters, Wharves, Piers, Bulkheads, Dolphins, Moorings, Fenders.	<b>10L+4T</b>
<b>2</b>	Shore processes: Continental drift, Beach wave interaction, Littoral drift, Shore stability, Tidal channels and basins.	<b>10L+3T</b>
<b>3</b>	Elements of hydrodynamics: Wave forces on structures, Diffraction theory, Fluid structure interaction.	<b>10L+3T</b>
<b>4</b>	Offshore marine structure: Mobile wharves, Radar platforms, Lighthouse platforms, Permanent drilling islands, Fixed drilling and production platforms, Mobile drilling units, Self-contained platforms. Analysis of fixed platforms.	<b>12L+4T</b>
	<b>Total</b>	<b>42L+14T</b>
	<b>No. of Weeks Required</b>	<b>14</b>
	<b>No. of Weeks in Hand</b>	<b>2</b>

**Books: Text and/or Reference:**

1. Mohamed El-Reedy, "Offshore Structures Design, Construction and Maintenance"
2. Srinivasan Chandrasekaran, "Offshore structural engineering reliability and risk assessment"
3. G Clauss, E Lehmann and C Ostergaard, "Offshore structures" Springer-Verlag
4. Athanasios Kalias, "Structural Reliability Analysis of offshore structures"

**Course Outcomes:**

At the end of this course, students will be able to

CO1. Describe the generation and propagation of wind, tides and waves.

CO2. Illustrate the various shore processes.

CO3. Define the various elements of hydrodynamics.

CO4. Identify the types of offshore marine structures.

Course code	PEC-CE-811(m)				
Category	Professional Elective Courses				
Course title	Water Resources Planning & Management				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)	Hydrology and Ground water (PCC-CE 506)				

**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
1.	<p><b>Planning and analysis of Water Resource Systems:</b> Introduction, System Analysis, Engineers and Policymakers</p> <p><b>Methods of Analysis:</b> Introduction, Evaluation of Time streams of Benefits and Costs. Plan formulation, Planning models and solution procedures, Lagranges Multipliers, Dynamic Programming, Recursive equations, Bellmans' principle of optimality. Curse of dimensionality of discrete dynamic programming. Examples</p>	<b>10L</b>
2.	<p><b>Reservoir Operation:</b> Sequential process, single Reservoir problem - with release as decision variable, with storage as decision variable (deterministic approach). Examples, Related Computer Programming. Multi-reservoir problems (Deterministic approach)</p>	<b>8L</b>

3.	<b>Water Resources Planning under Uncertainty:</b> Introduction, probability concepts and Methods –Random variable and Distributions, Univariate probability Distributions ,properties of Random variable – Moment and Expectation ( Univariate Distributions) , Moment Generating Functions, Measures of Central tendency, Measures of Dispersion, Measures of symmetry (Skewness), measures of peaked ness (kurtosis), examples	<b>8L</b>
4.	<b>Stochastic River Basin Planning Model:</b> Introduction, Reservoir operation, Stochastic, Dynamic programming, Operating Model, Probability Distribution of Storage volumes and Releases, examples	<b>8L</b>
5.	<b>Water quality Management:</b> Prediction and Simulation, Water quality Management Modeling	<b>8L</b>
<b>Total</b>		<b>42L</b>
<b>Total week required</b>		<b>14</b>
<b>No. of week reserved</b>		<b>02</b>

**Books: Text and/or Reference:**

1. *Applied Hydrology* by V.T. Chow , Mcgraw-Hill
2. *Stochastic Hydrology* by Jayaram Reddy
3. *Water Resources Engineering* by Larry W Mays, John Wiley & Sons(Asia)
4. *Water Resources Systems Planning & Analysis* by Ddenice P Loucks, Jery R Stedinger & Douglas A Heinth, Prentice Hall

**Course Outcomes:**

At the end of this course, students will be able to

**CO1:** Plan & analyze of water resources system.

**CO2:** Understand and evaluate the operation of reservoir.

**CO3:** Gain knowledge on water resources planning under uncertainty.

**CO4:** Execute operating model & dynamic programming with quality management modeling.

<b>Course code</b>	<b>PEC-CE-811(n)</b>				
<b>Category</b>	<b>Professional Elective Courses</b>				
<b>Course title</b>	<b>Basics of Computational Hydraulics</b>				
<b>Scheme and</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Semester – VIII</b>

<b>Credits</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>	
<b>Pre-requisites (if any)</b>	<b>Fluid Mechanics-II (ESC-CE-402)</b> <b>Hydrology and Ground water (PCC-CE 506)</b>				

**Theory Syllabus:**

<b>Module</b>	<b>Course Content</b>	<b>Lecture / Tutorial Period</b>
1.	<b>Introduction:</b> Modelling Theory - Physical modelling, analytical modelling, numerical modeling; classification of models based on i) Scale (space and time), ii) Solution (analytical and numerical); Concept of computational hydraulics; Processes involved in model development and application.	<b>8L</b>
2.	<b>Modeling Fluid Flow Problems:</b> Governing equations- Conservation of mass, conservation of momentum, conservation of energy; Mathematical classification of flow equations, solution of ordinary differential equations and partial differential equations, boundary conditions; Solution of Saint-Venant Equations - Kinematic wave solution, Diffusive wave solution and full dynamic solution; Characteristic form of Saint-Venant Equations	<b>10L</b>
3.	<b>Numerical Solution Schemes:</b> Discrete solution of governing equations, Space discretization - Structured grids and unstructured grids, grid generation, time discretization.	<b>6L</b>
4.	<b>Finite Difference Method:</b> General concept, approximation of derivatives; Finite difference formulation for ordinary differential equations - Explicit schemes, Implicit schemes, Mixed schemes and weighted average schemes; Finite difference formulation for partial differential equations - initial conditions, boundary conditions, explicit and implicit schemes; The Preissmann Scheme, The Abbott-Ionescu scheme.	<b>10L</b>
5.	<b>Finite Volume Method:</b> General concept, Steps in application of Finite Volume Method- Surface and volume integrals, Discretization of convective fluxes, Discretization of diffusive fluxes, evaluation of time derivative, boundary conditions.	<b>8L</b>
<b>Total</b>		<b>42L</b>
<b>Total week required</b>		<b>14</b>
<b>No. of week reserved</b>		<b>02</b>

**Books: Text and/or Reference:**

*Computational Hydraulics* M. B. Abbott and A. W. Minns Routledge, London, 2016

*Computational Hydraulics – An Introduction* C. B. Vreugdenhil, Springer – Verlag, New York, 1989

*Computational Hydraulics* C. A. Brebbia and A. J. Ferrante, Butterworth-Heinemann, 2013.

*Computational Methods for Fluid Dynamics*, J. H. Ferziger and M. Peric Springer, London, 2002.

**Course Outcomes:**

At the end of this course, students will be able to

CO1. Identify the complexities involved in fluid flow problems.

CO2. Model the specific flow problem in terms of defining the governing equations, initial and boundary conditions and appropriate solution schemes to use.

CO3. Develop finite difference formulation of ordinary and partial differential equations of flow problems.

CO4. Develop finite volume formulation of ordinary and partial differential equations of flow problems.

**Appendix-IV**  
**Common Open Elective Courses (OEC)**

# Detail syllabus of Open Elective Courses (OEC) is referred to OEC Booklet