

# BACHELOR OF TECHNOLOGY CIVIL ENGINEERING

## SYLLABUS FOR FLEXIBLE CURRICULUM

(EFFECTIVE FROM 2015-16 ONWARDS)

DEPARTMENT OF CIVIL ENGINEERING  
NATIONAL INSTITUTE OF TECHNOLOGY  
TIRUCHIRAPPALLI- 620 015



**B. Tech.**

IN

**CIVIL ENGINEERING**

**FLEXIBLE CURRICULUM**

**(For students admitted in 2015-16)**



**DEPARTMENT OF CIVIL ENGINEERING  
NATIONAL INSTITUTE OF TECHNOLOGY  
TIRUCHIRAPPALLI – 620 015**

**TAMIL NADU, INDIA**



## CURRICULUM

The total minimum credits for completing the B.Tech. Programme in Civil Engineering is **179** [68 + 111]).

### MINIMUM CREDIT REQUIREMENT FOR THE VARIOUS COURSE CATEGORIES

The structure of B.Tech. Programmes shall have General Institute Requirements (GIR), Programme Core (PC), Elective Courses (PE, OE and MI) and Essential Programme Laboratory Requirements (ELR) as follows:

SI.No.	COURSE CATEGORY	Number of Courses	Number of Credits
1.	General Institute Requirement (GIR)	17	68
2.	Programme Core (PC)	20	65
3.	Essential Programme Laboratory Requirement (ELR)	2 per session	16
4.	Elective courses a. Programme Electives (PE) b. Open Electives (OE) c. Minor (MI)  A student should be allowed a minimum of 50% of the total electives of a programme from (b) and (c) if so desired by the student.	10	30
<b>TOTAL</b>			<b>179</b>

**(I) GENERAL INSTITUTE REQUIREMENTS**

<b>Sl.No.</b>	<b>Name of the course</b>	<b>Number of Courses</b>	<b>Maximum Credits</b>
1.	Mathematics	4	14
<b>2.</b>	<b>Physics*</b>	<b>2</b>	<b>7</b>
<b>3.</b>	<b>Chemistry*</b>	<b>2</b>	<b>7</b>
4.	Humanities	1	3
5.	Communication	2	6
6.	Energy and Environmental Engineering	1	2
7.	Professional Ethics	1	3
<b>8.</b>	<b><i>Engineering Graphics</i></b>	<b><i>1</i></b>	<b><i>3</i></b>
<b>9.</b>	<b><i>Engineering Practice</i></b>	<b><i>1</i></b>	<b><i>2</i></b>
10.	Basic Engineering	2	4
11.	Introduction to Computer Programming	1	3
<b>12.</b>	<b>Branch Specific Course** (Introduction to Branch of Study)</b>	<b>1</b>	<b>2</b>
<b>13.</b>	<b><i>Summer Internship</i></b>	<b><i>1</i></b>	<b><i>2</i></b>
<b>14.</b>	<b><i>Project work</i></b>	<b><i>1</i></b>	<b><i>6</i></b>
<b>15.</b>	<b><i>Comprehensive Viva</i></b>	<b><i>1</i></b>	<b><i>3</i></b>
16.	Industrial lecture	-	1
17.	NSS / NCC / NSC	-	0
	<b>Total</b>	<b>17 (Excluding Italics)</b>	<b>68</b>

\*including Lab

\*\* Commence during Orientation Programme

**I. GENERAL INSTITUTE REQUIREMENTS****1. MATHEMATICS**

Sl. No.	Course Code	Course Title	Credits
1.	MAIR11	Mathematics - I	4
2.	MAIR12	Mathematics - II	4
3.	MAIR33	Probability, Statistics and Linear Programming	3
4.	MAIR41	Numerical Techniques	3
<b>Total</b>			<b>14</b>

**2. PHYSICS**

Sl. No.	Course Code	Course Title	Credits
1.	PHIR11	Physics – I	3
2.	PHIR12	Physics – II	4
<b>Total</b>			<b>7</b>

**3. CHEMISTRY**

Sl. No.	Course Code	Course Title	Credits
1.	CHIR11	Chemistry – I	3
2.	CHIR13	Chemistry – II	4
<b>Total</b>			<b>7</b>

**4. COMMUNICATION**

Sl. No.	Course Code	Course Title	Credits
1.	HSIR11	English for Communication	3
2.	HSIR12	Professional Communication	3
<b>Total</b>			<b>6</b>

**5. HUMANITIES**

Sl. No.	Course Code	Course Title	Credits
1.	HSIR13*	Industrial economics and foreign trade	3
<b>Total</b>			<b>3</b>

\* The above course will be offered in July Session

**6. ENERGY AND ENVIRONMENTAL ENGINEERING**

Sl. No.	Course Code	Course Title	Credits
1.	ENIR11	Energy and environmental engineering	2
<b>Total</b>			<b>2</b>

**7. PROFESSIONAL ETHICS**

Sl. No.	Course Code	Course Title	Credits
1.	HSIR14**	Professional Ethics	3
<b>Total</b>			<b>3</b>

\*\* The above course will be offered in July Session

**8. ENGINEERING GRAPHICS**

Sl. No.	Course Code	Course Title	Credits
1.	MEIR12	Engineering Graphics	3
<b>Total</b>			<b>3</b>

**9. ENGINEERING PRACTICE**

Sl. No.	Course Code	Course Title	Credits
2.	PRIR11	Engineering Practice	2
<b>Total</b>			<b>2</b>

**10. BASIC ENGINEERING**

Sl. No.	Course Code	Course Title	Credits
1.	MEIR11	Basics of Mechanical Engineering	2
2.	EEIR11	Basics of Electrical and Electronics Engineering	2
<b>Total</b>			<b>4</b>

**11. INTRODUCTION TO COMPUTER PROGRAMMING**

Sl. No.	Course Code	Course Title	Credits
1.	CSIR11	Basics of programming	3
<b>Total</b>			<b>3</b>

**12. BRANCH SPECIFIC COURSE**

Sl. No.	Course Code	Course Title	Credits
1.	CEIR15	Introduction to Civil Engineering	2
<b>Total</b>			<b>2</b>

**13. SUMMER INTERNSHIP**

Sl. No.	Course Code	Course Title	Credits
1.	CEIR16 <sup>#</sup>	INTERNSHIP / INDUSTRIAL TRAINING / ACADEMIC ATTACHMENT (2 to 3 months duration during summer vacation)	2
<b>Total</b>			<b>2</b>

The student should undergo industrial training/internship for a minimum period of two months during the summer vacation of 3<sup>rd</sup> year. Attachment with an academic institution within the country (IISc/IITs/NITs/IIITs and CFTIs) or university abroad is also permitted instead of industrial training.

**# to be evaluated at the beginning of VII semester by assessing the report and seminar presentations.**

**14. PROJECT WORK**

Sl. No.	Course Code	Course Title	Credits
1.	CEIR17	Project Work	6
<b>Total</b>			<b>6</b>

**15. COMPREHENSIVE VIVA**

Sl. No.	Course Code	Course Title	Credits
1.	CEIR18	Comprehensive viva	3
<b>Total</b>			<b>3</b>

**16. INDUSTRIAL LECTURE**

Sl. No.	Course Code	Course Title	Credits
1.	CEIR19	Industrial Lecture	1
<b>Total</b>			<b>1</b>

A course based on industrial lectures shall be offered for 1 credit. A minimum of five lectures of two hours duration by industry experts will be arranged by the Department. The evaluation methodology, will in general, be based on quizzes at the end of each lecture.

**17. NSS / NCC / NSO**

Sl. No.	Course Code	Course Title	Credits
1.	SWIR11	NSS / NCC / NSO	0
<b>Total</b>			<b>0</b>



**(II) PROGRAMME CORE (PC)**

Sl. No.	Course Code	Course Title	Prerequisites	Credits
1.	CEPC10	Engineering Mechanics	-	3
2.	CEPC11	Strength of Materials	-	3
3.	CEPC12	Mechanics of Fluids	-	3
4.	CEPC13	Environmental Engineering-I	-	3
5.	CEPC14	Surveying	-	3
6.	CEPC15	Concrete Technology	-	3
7.	CEPC16	Mechanics of Solids	CEPC11	3
8.	CEPC17	Hydrology and Water Resources Engineering	CEPC12	3
9.	CEPC18	Environmental Engineering-II	CEPC13	4
10.	CEPC19	Geotechnical Engineering-I	-	3
11.	CEPC20	Highway and Pavement Engineering	-	4
12.	CEPC21	Analysis of Indeterminate Structures	CEPC16	3
13.	CEPC22	Basic Reinforced Concrete Design	-	4
14.	CEPC23	Geotechnical Engineering-II	CEPC19	3
15.	CEPC24	Basic Steel Structural Elements	-	3
16.	CEPC25	Advanced Structural Analysis	CEPC21	3
17.	CEPC26	Advanced Reinforced Concrete Design	CEPC22	4
18.	CEPC27	Advanced Steel Structural Elements	CEPC24	4
19.	CEPC28	Railway, Airport and Harbour Engineering	-	3
20.	CEPC29	Irrigation and Hydraulic Engineering	CEPC17	3
<b>Total</b>				<b>65</b>

**(III) ELECTIVES****a. PROGRAMME ELECTIVE (PE)**

Students pursuing B.Tech in Civil Engineering should complete at least five courses from the Programme Electives listed below.

Sl. No.	Course Code	Course Title	Prerequisites	Credits
1.	CEPE10	Construction Techniques and Equipments	-	3
2.	CEPE11	Elementary Structural Dynamics	CEPC10	3
3.	CEPE12	Maintenance and Rehabilitation of Structures	CEPC15	3
4.	CEPE13	Construction Management	-	3
5.	CEPE14	Structural System Analysis	CEPC25	3
6.	CEPE15	Prestressed Concrete Structures	CEPC26	3
7.	CEPE16	Steel Structural Systems	CEPC27	3
8.	CEPE17	Steel Concrete Composite Structures	CEPC26 CEPC27	3
9.	CEPE18	Earthquake Resistant Structures	CEPC25 CEPE11	3
10.	CEPE19	Traffic Engineering and Safety	CEPC20	3
11.	CEPE20	Pavement Analysis and Design	CEPC20	3
12.	CEPE21	Transportation Planning	CEPC20	3
13.	CEPE22	Air Pollution Management	CEPC18	3
14.	CEPE23	Industrial Wastewater Treatment	CEPC18	3
15.	CEPE24	Environmental Management and Impact Assessment	CEPC18	3
16.	CEPE25	Solid Waste Management Techniques	CEPC18	3
17.	CEPE26	Models for Air and Water Quality	CEPC18	3
18.	CEPE27	Advanced Foundation Engineering	CEPC23	3
19.	CEPE28	Geotechnical Earthquake Engineering	CEPC23	3



20.	CEPE29	Reinforced Earth and Geotextiles	CEPC23	3
21.	CEPE30	Earth and Earth Retaining Structures	CEPC23	3
22.	CEPE31	Marine Foundation Engineering	CEPC23	3
23.	CEPE32	Geodetic Surveying	CEPC14	3
24.	CEPE33	Advanced Surveying Techniques	CEPC14	3
25.	CEPE34	Groundwater Hydrology	CEPC12	3
26.	CEPE35	Applied Hydraulics Engineering	CEPC12	3
27.	CEPE36	Design of Hydraulic Structures	CEPC17	3
28.	CEPE37	Simulation Modelling for Water Resources Engineering	CEPC17	3
29.	CEPE38	Design of offshore and Coastal structures	CEPC23 CEPC24	3
30.	CEPE39	Coastal Engineering	CEPC12	3
31.	CEPE40	Disaster Modelling and Management	CEPC12 CEPC17	3
32.	CEPE41	Prefabricated structures	-	3

#### b. OPEN ELECTIVE (OE)

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

Sl.No.	Course Code	Course Title	Prerequisites	Credits
1.	CEOE10	Remote Sensing and GIS	-	3
2.	CEOE11	Ocean Energy	-	3
3.	CEOE12	Earthquake Engineering	-	3
4.	CEOE13	Urban and Regional Planning	-	3
5.	CEOE14	Experimental Stress Analysis	-	3
6.	CEOE15	Health Monitoring of Structures	-	3
7.	CEOE16	Forensic Engineering	-	3

**c. MINOR (MI) (offered for the students of other departments)**

Students who have registered for B.Tech. Minor in Civil Engineering can opt to study any 5 of the courses listed below.

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

**Note: Student should be allowed a minimum of 50% of the total electives of a programme from Open electives and Minor, if so desired by the student.**

**(IV) ESSENTIAL PROGRAMME LABORATORY REQUIREMENT (ELR)**

Sl.No.	Course Code	Course Title	Co requisites	Credits
1.	CELR10	Strength of Materials and Concrete Laboratory	-	2
2.	CELR11	Survey Laboratory	-	2
3.	CELR12	Fluid Mechanics Laboratory	-	2
4.	CELR13	Environmental Engineering Laboratory	-	2
5.	CELR14	Geotechnical Engineering Laboratory	-	2
6.	CELR15	Building Planning and Drawing	-	2
7.	CELR17	Computational Laboratory	-	2
8.	CELR18	Estimating, Costing and Valuation	-	2
<b>Total</b>				<b>16</b>

**NOTE: Students can register for 2 laboratory courses during one session along with regular courses (PC / PE / OE / MI).**

**V. ADVANCED LEVEL COURSES FOR B.Tech. (HONOURS)**

A student can obtain B.Tech. (Honours) degree provided the student has;

- i. Registered at least for 12 theory courses and 2 ELRs in the second year.
- ii. Consistently obtained a minimum GPA of 8.5 in the first four sessions
- iii. Continue to maintain the same GPA of 8.5 in the subsequent sessions (including the Honours courses)
- iv. Completed 3 additional theory courses specified for the Honors degree of the programme.
- v. Completed all the courses registered, in the first attempt and in four years of study.

Sl.No.	Course Code	Course Title	Pre requisites	Credits
1.	CEHO10	Advanced strength of materials	CEPC16	3
2.	CEHO11	Basics of Finite Element Methods	CEPC25	3
3.	CEHO12	Elementary Theory of Elasticity and Introduction to Plasticity	CEPC16	3
4.	CEHO13	Nonlinear analysis of Structures	CEPC25	3
5.	CEHO14	Theory of Plates And Introduction to Shells	CEPC16	3
6.	CEHO15	Theory of Traffic flow	CEPC20	3
7.	CEHO16	Pavement Construction and management	CEPC20	3
8.	CEHO17	Soil Dynamics and Machine foundations	CEPC23	3
9.	CEHO18	Numerical Modelling in Geotechnical Engineering	CEPC23	3
10.	CEHO19	Physicochemical Methods for Water and Wastewater Treatment	CEPC18	3
11.	CEHO20	Biological Treatment of Wastewater Treatment	CEPC18	3
12.	CEHO21	Free surface flow	CEPC17	3
13.	CEHO22	Computational fluid dynamics	CEPC17	3
14.	CEHO23	Wave hydrodynamics	CEPC17	3
15.	CEHO24	Advanced Remote Sensing Techniques	CEPC14	3



**Details of the flow of courses for a particular programme should be made available to the students at the beginning of the programme (I Year). The feasible year (I to IV year of study) and session of study for each core course should also be given.**

**Course flow:**  $X \rightarrow Y Z$  Where X, Y, and Z are courses

The following table should be prepared before the commencement of the programme

Sl. No.	Course Code	Course Title	Year of Study	Session/s
1.	MAIR11	Mathematics - I	I	July / January
2.	HSIR11	English for Communication	I	July / January
3.	PHIR11	Physics – I	I	July / January
4.	CHIR11	Chemistry – I	I	July / January
5.	CSIR11	Basics of Programming	I	July / January
6.	CEIR15	Branch Specific Course	I	July / January
7.	EEIR11	Basics of Electrical and Electronics Engineering	I	July / January
8.	MEIR11	Basics of Mechanical Engineering	I	July / January
9.	MEIR12	Engineering Graphics	I	July / January
10.	HSIR12	Professional Communication	I	July/ January
11.	MAIR12	Mathematics - II	I	July/ January
12.	PHIR12	Physics – II	I	July/ January
13.	CHIR13	Chemistry – II	I	July/ January
14.	ENIR11	Energy and environmental engineering	I	July/ January
15.	CEPC10	Engineering Mechanics	I	July/ January
16.	PRIR11	Engineering Practice	I	July/ January
17.	MAIR33	Probability, Statistics and Linear Programming	II	July / January
18.	CEPC11	Strength of Materials	II	July / January
19.	CEPC12	Hydraulics and Fluid Machinery	II	July / January



20.	CEPC13	Environmental Engineering -I	II	July / January
21.	CEPC14	Surveying	II	July / January
22.	CEPC15	Concrete Technology	II	July / January
23.	CELR10	Strength of materials and concrete Laboratory	II	July / January
24.	CELR11	Survey Laboratory	II	July / January
25.	MAIR41	Numerical Techniques	II	July/ January
26.	CEPC16	Mechanics of Solids	II	July/ January
27.	CEPC17	Hydrology and Water Resources Engineering	II	July/ January
28.	CEPC18	Environmental Engineering-II	II	July/ January
29.	CEPC19	Geotechnical Engineering-I	II	July/ January
30.		Programme Elective 1 <sup>\$</sup>	II	July/ January
31.		Open Elective 1*	II	July/ January
32.		Minor 1 <sup>#</sup>	II	July/ January
33.	CELR12	Fluid mechanics Laboratory	II	July/ January
34.	CELR15	Building Planning and Drawing	II	July/ January
35.	CEPC20	Highway and Pavement Engineering	III	July / January
36.	CEPC21	Analysis of indeterminate Structures	III	July / January
37.	CEPC22	Basic Reinforced Concrete Design	III	July / January
38.	CEPC23	Geotechnical Engineering-II	III	July / January
39.		Programme Elective 2 <sup>\$</sup>	III	July / January
40.		Programme Elective 3 <sup>\$</sup>	III	July / January
41.		Open Elective 2*	III	July / January
42.		Minor 2 <sup>#</sup>	III	July / January
43.		Honours 1 <sup>+</sup>	III	July / January
44.	CELR13	Environmental Engineering Laboratory	III	July / January
45.	CELR14	Geotechnical Engineering Laboratory	III	July / January



46.	CEPC24	Basic Steel Structural Elements	III	July/ January
47.	CEPC25	Advanced Structural Analysis	III	July/ January
48.	CEPC26	Advanced Reinforced Concrete Design	III	July/ January
49.	CEPC28	Railway, Airport and Harbour Engineering		July/ January
50.		Programme Elective 4 <sup>\$</sup>	III	July/ January
51.		Programme Elective 5 <sup>\$</sup>	III	July/ January
52.		Open Elective 3 <sup>*</sup>	III	July/ January
53.		Minor 3 <sup>#</sup>	III	July/ January
54.		Honours 2 <sup>+</sup>	III	July/ January
55.	CEIR16	Internship / industrial training / academic attachment	III	July/ January
56.	CEIR19	Industrial Lecture	III	July/ January
57.	CELR17	Computational Laboratory	III	July/ January
58.	HSIR14	Professional Ethics	IV	July / January
59.	CEPC27	Advanced Steel Structural Elements	IV	July / January
60.	CEPC29	Irrigation and Hydraulic Engineering	IV	July / January
61.		Programme Elective 6 <sup>\$</sup>	IV	July / January
62.		Programme Elective 7 <sup>\$</sup>	IV	July / January
63.		Open Elective 4 <sup>*</sup>	IV	July / January
64.		Minor 4 <sup>#</sup>	IV	July / January
65.		Honors 3 <sup>+</sup>	III	July / January
66.		Honors 4 <sup>+</sup>	III	July / January
67.	CEIR18	Comprehensive viva	IV	July / January
68.	CELR19	Estimation, Costing and Valuation	IV	July / January
69.	HSIR13	Industrial Economics and Foreign Trade	IV	July/ January
70.		Programme Elective 8 <sup>\$</sup>	IV	July/ January
71.		Programme Elective 9 <sup>\$</sup>	IV	July/ January
72.		Programme Elective 10 <sup>\$</sup>	IV	July/ January





73.		Open Elective 5*	IV	July/ January
74.		Minor 5#	IV	July/ January
75.		Honors 5+	IV	July/ January
76.	CEIR17	Project Work	IV	July/ January

**Note:**

\$To be offered as a Programme Elective for Civil Engineering students

\* To be offered as an Open Elective for other Department students

# To be offered as Minor for other Department students

+ To be offered for students who register for B.Tech. (Honours) in Civil Engineering

**ROADMAP OF FLEXIBLE CURRICULUM****FOR B.Tech. (CIVIL ENGINEERING) STUDENTS**

The courses that must be completed by the students of Civil Engineering Department over a period of eight sessions, and the courses offered during each session are listed below.

The order in which students may register for a course is formulated based on prerequisite requirements. However, students may register for courses by virtue of their choice, provided that they meet the prerequisite requirement.

Sl. No.	Course Code	Course Title	Prerequisite / Co requisite	Credit	Type	Year of Study	Session/s
1.	MAIR11	Mathematics - I	-	4	GIR	I	July / January
2.	HSIR11	English Communication for	-	3	GIR	I	July / January
3.	PHIR11	Physics – I	-	3	GIR	I	July / January
4.	CHIR11	Chemistry – I	-	3	GIR	I	July / January
5.	CSIR11	Basics of Programming	-	3	GIR	I	July / January
6.	CEIR15	Branch Specific Course	-	2	GIR	I	July / January
7.	EEIR11	Basics of Electrical and Electronics Engineering	-	2	GIR	I	July / January
8.	MEIR11	Basics of Mechanical Engineering	-	2	GIR	I	July / January
9.	MEIR12	Engineering Graphics	-	3	GIR	I	July / January
<b>Total No. of Credits</b>				<b>25</b>			

Sl. No.	Course Code	Course Title	Prerequisite / Co requisite	Credit	Type	Year of Study	Session/s
1.	HSIR12	Professional Communication	-	3	GIR	I	July / January
2.	MAIR12	Mathematics - II	-	4	GIR	I	July / January
3.	PHIR12	Physics – II	-	4	GIR	I	July / January
4.	CHIR13	Chemistry – II	-	4	GIR	I	July / January
5.	ENIR11	Energy and environmental engineering	-	2	GIR	I	July / January
6.	CEPC10	Engineering Mechanics	-	3	PC	I	July / January
7.	PRIR11	Engineering Practice	-	2	GIR	I	July / January
<b>Total No. of Credits</b>				<b>22</b>			



Sl. No.	Course Code	Course Title	Prerequisite / Co requisite	Credit	Type	Year of Study	Session/s
1.	MAIR33	Probability, Statistics and Linear Programming	-	3	GIR	II	July / January
2.	CEPC11	Strength of Materials	-	3	PC	II	July / January
3.	CEPC12	Hydraulics and Fluid Machinery	-	3	PC	II	July / January
4.	CEPC13	Environmental Engineering -I	-	3	PC	II	July / January
5.	CEPC14	Surveying	-	3	PC	II	July / January
6.	CEPC15	Concrete Technology	-	3	PC	II	July / January
7.	CELR10	Strength of materials and concrete Laboratory	-	2	ELR	II	July / January
8.	CELR11	Survey Laboratory	-	2	ELR	II	July / January
<b>Total No. of Credits</b>				<b>22</b>			

Sl. No.	Course Code	Course Title	Prerequisite / Co requisite	Credit	Type	Year of Study	Session/s
1.	MAIR41	Numerical Techniques	-	3	GIR	II	July / January
2.	CEPC16	Mechanics of Solids	CEPC11	3	PC	II	July / January
3.	CEPC17	Hydrology and Water Resources Engineering	CEPC12	3	PC	II	July / January
4.	CEPC18	Environmental Engineering-II	CEPC13	4	PC	II	July / January
5.	CEPC19	Geotechnical Engineering-I	-	3	PC	II	July / January
6.		Programme Elective 1 <sup>s</sup>	CEPC10 CEPC12 CEPC14 CEPC15	3	PE	II	July / January
7.		Open Elective 1*	-	3	OE	II	July / January
8.		Minor 1 <sup>#</sup>	-	3	MI	II	July / January
9.	CELR12	Fluid Mechanics Laboratory	-	2	ELR	II	July / January
10.	CELR15	Building Planning and Drawing	-	2	ELR	II	July / January
<b>Total No. of Credits</b>				<b>23</b>			



Sl. No.	Course Code	Course Title	Prerequisite / Co requisite	Credit	Type	Year of Study	Session/s
1.	CEPC20	Highway and Pavement Engineering	-	4	PC	III	July / January
2.	CEPC21	Analysis of Indeterminate Structures	CEPC16	3	PC	III	July / January
3.	CEPC22	Basic Reinforced Concrete Design	-	4	PC	III	July / January
4.	CEPC23	Geotechnical Engineering-II	CEPC19	3	PC	III	July / January
5.		Programme Elective 2 <sup>§</sup>	CEPC10 CEPC12	3	PE	III	July / January
6.		Programme Elective 3 <sup>§</sup>	CEPC14 CEPC15 CEPC17 CEPC18	3	PE	III	July / January
7.		Open Elective 2*	-	3	OE	III	July / January
8.		Minor 2 <sup>#</sup>	-	3	MI	III	July / January
9.		Honors 1 <sup>+</sup>	CEPC14 CEPC16 CEPC17 CEPC18	3	HO	III	July / January
10.	CELR13	Environmental Engineering Laboratory	-	2	ELR	III	July / January
11.	CELR14	Geotechnical Engineering Laboratory	-	2	ELR	III	July / January
<b>Total No. of Credits</b>				<b>24</b>			

Sl. No.	Course Code	Course Title	Prerequisite / Co requisite	Credit	Type	Year of Study	Session/s
1.	CEPC24	Basic Steel Structural Elements	-	3	PC	III	July / January
2.	CEPC25	Advanced Structural Analysis	CEPC21	3	PC	III	July / January
3.	CEPC26	Advanced Reinforced Concrete Design	CEPC22	4	PC	III	July / January
4.	CEPC28	Railway, Airport and Harbour Engineering	-	3	PC	III	July / January
5.		Programme Elective 4 <sup>§</sup>	CEPC10 CEPC12	3	PE	III	July / January
6.		Programme Elective 5 <sup>§</sup>	CEPC14 CEPC15 CEPC17 CEPC18 CEPC20 CEPC23	3	PE	III	July / January
7.		Open Elective 3*	-	3	OE	III	July / January
8.		Minor 3 <sup>#</sup>	-	3	MI	III	July / January
9.		Honors 2 <sup>+</sup>	CEPC14 CEPC16 CEPC17 CEPC18 CEPC20 CEPC23	3	HO	III	July / January



10.	CEIR16	Internship / industrial training / academic attachment	-	2	GIR	III	July / January
11.	CEIR19	Industrial Lecture	-	1	GIR	III	July / January
12.	CELR17	Computational Laboratory	-	2	ELR	III	July / January
<b>Total No. of Credits</b>				<b>24</b>			

Sl. No.	Course Code	Course Title	Prerequisite / Co requisite	Credit	Type	Year of Study	Session/s
1.	HSIR14	Professional Ethics	-	3	GIR	IV	July / January
2.	CEPC27	Advanced Steel Structural Elements	CEPC24	4	PC	IV	July / January
3.	CEPC29	Irrigation and Hydraulic Engineering	CEPC17	3	PC	IV	July / January
4.		Programme Elective 6 <sup>s</sup>	CEPC12 CEPC17	3	PE	IV	July / January
5.		Programme Elective 7 <sup>s</sup>	CEPC18 CEPC20 CEPC23 CEPC24 CEPC25 CEPE11 CEPC26	3	PE	IV	July / January
6.		Open Elective 4*	-	3	OE	IV	July / January
7.		Minor 4 <sup>#</sup>	-	3	MI	IV	July / January
8.		Honors 3 <sup>+</sup>	CEPC14 CEPC16	3	HO	III	July / January
9.		Honors 4 <sup>+</sup>	CEPC17 CEPC18 CEPC20 CEPC23 CEPC25	3	HO	III	July / January
10.	CEIR18	Comprehensive viva	-	3	GIR	IV	July / January
11.	CELR19	Estimation, Costing and Valuation	-	2	ELR	IV	July / January
<b>Total No. of Credits</b>				<b>21</b>			

Sl. No.	Course Code	Course Title	Prerequisite / Co requisite	Credit	Type	Year of Study	Session/s
1.	HSIR13	Industrial Economics and Foreign Trade	-	3	GIR	IV	July / January
2.		Programme Elective 8 <sup>s</sup>	CEPC12 CEPC17	3	PE	IV	July / January
3.		Programme Elective 9 <sup>s</sup>	CEPC18 CEPC20	3	PE	IV	July / January
4.		Programme Elective 10 <sup>s</sup>	CEPC23 CEPC24 CEPC25 CEPE11 CEPC26 CEPC27	3	PE	IV	July / January



5.		Open Elective 5*	-	3	OE	IV	July / January
6.		Minor 5#	-	3	MI	IV	July / January
7.		Honors 5+	CEPC14 CEPC16 CEPC17 CEPC18 CEPC20 CEPC23 CEPC25	3	HO	IV	July / January
8.	CEIR17	Project Work	-	6	GIR	IV	July / January
<b>Total No. of Credits</b>				<b>18</b>			

**Note:**

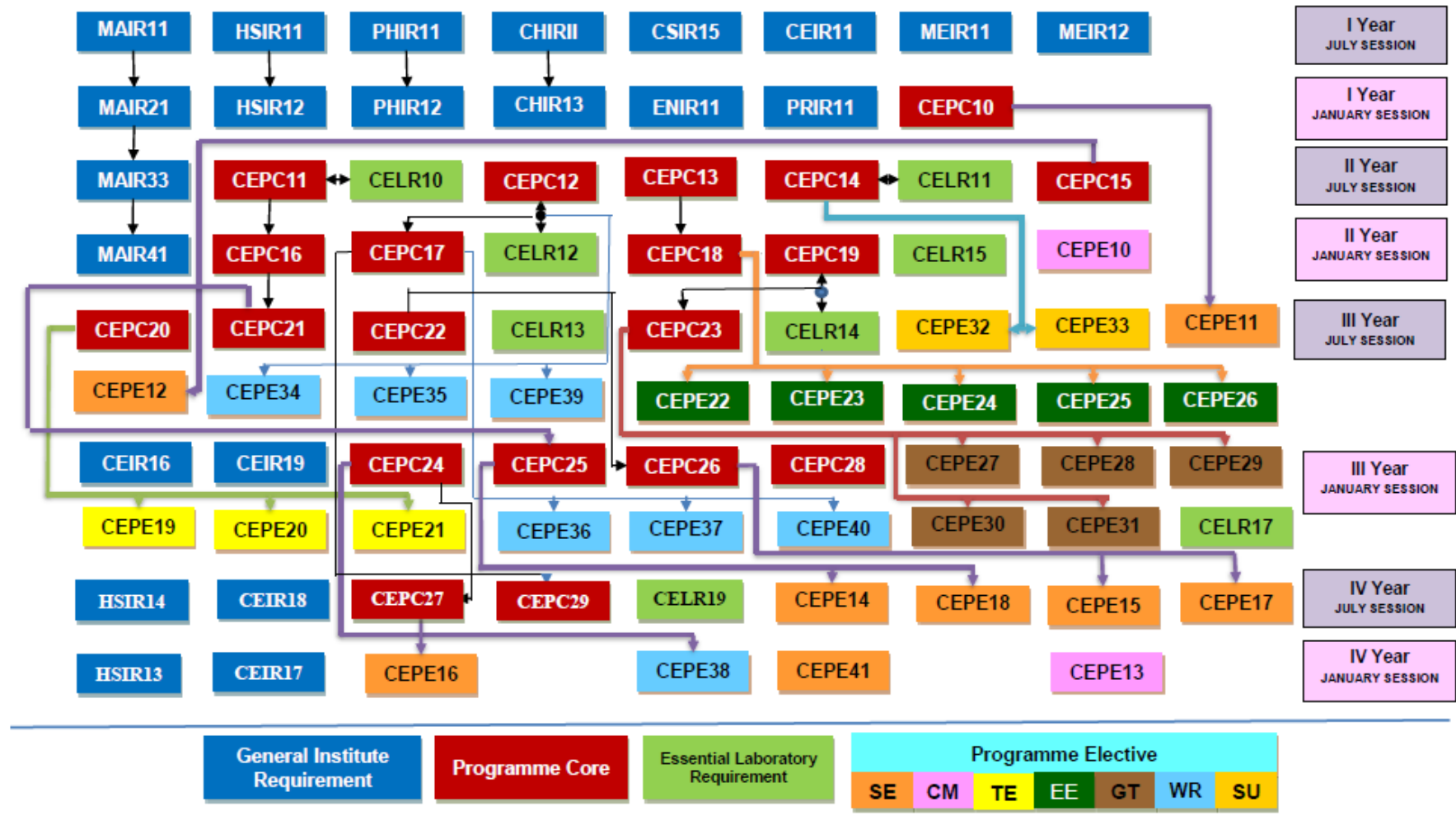
\$To be offered as a Programme Elective for Civil Engineering students

\* To be offered as an Open Elective for other Department students

# To be offered as Minor for other Department students

+ To be offered for students who register for B.Tech. (Honours) in Civil Engineering

## FLOWCHART FOR FLEXIBLE CURRICULUM / CIVIL ENGINEERING



**Details of Courses**

<b>Number of Courses for JULY Session (over 4 years)</b>					
	<b>Session 1</b>	<b>Session 3</b>	<b>Session 5</b>	<b>Session 7</b>	<b>TOTAL</b>
<b>GIR</b>	9	1	-	2	<b>12</b>
<b>PC</b>	-	5	4	2	<b>11</b>
<b>ELR</b>	-	2	2	1	<b>5</b>
<b>PE</b>	-	-	2	2	<b>4</b>
<b>Total</b>	<b>9</b>	<b>8</b>	<b>8</b>	<b>7</b>	<b>32</b>

<b>Number of Courses for JANUARY Session (over 4 years)</b>					
	<b>Session 2</b>	<b>Session 4</b>	<b>Session 6</b>	<b>Session 8</b>	<b>TOTAL</b>
<b>GIR</b>	6	1	2	2	<b>11</b>
<b>PC</b>	1	4	4	-	<b>9</b>
<b>ELR</b>	-	2	1	-	<b>3</b>
<b>PE</b>	-	1	2	3	<b>6</b>
<b>Total</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>5</b>	<b>29</b>

<b>Total Courses (Over 4 years)</b>					
	<b>I year</b>	<b>II year</b>	<b>III Year</b>	<b>IV year</b>	<b>TOTAL</b>
<b>GIR</b>	15	2	2	4	<b>23</b>
<b>PC</b>	1	9	8	2	<b>20</b>
<b>ELR</b>	-	4	3	1	<b>8</b>
<b>PE</b>	-	1	4	5	<b>10</b>
<b>Total</b>	<b>16</b>	<b>16</b>	<b>17</b>	<b>12</b>	<b>61</b>



**Details of Credits**

<b>No. Of Credits for JULY Session (over 4 years)</b>					
	<b>Session 1</b>	<b>Session 3</b>	<b>Session 5</b>	<b>Session 7</b>	<b>TOTAL</b>
<b>GIR</b>	25	3	-	6	<b>34</b>
<b>PC</b>	-	15	14	7	<b>36</b>
<b>ELR</b>	-	4	4	2	<b>10</b>
<b>PE</b>	-	-	6	6	<b>12</b>
<b>Total</b>	<b>25</b>	<b>22</b>	<b>24</b>	<b>21</b>	<b>92</b>

<b>No. of Credits for JANUARY Session (over 4 years)</b>					
	<b>Session 2</b>	<b>Session 4</b>	<b>Session 6</b>	<b>Session 8</b>	<b>TOTAL</b>
<b>GIR</b>	19	3	3	9	<b>34</b>
<b>PC</b>	3	13	13	-	<b>29</b>
<b>ELR</b>	-	4	2	-	<b>6</b>
<b>PE</b>	-	3	6	9	<b>18</b>
<b>Total</b>	<b>22</b>	<b>23</b>	<b>24</b>	<b>18</b>	<b>87</b>

<b>Total Credits (Over 4 years)</b>					
	<b>I year</b>	<b>II year</b>	<b>III Year</b>	<b>IV year</b>	<b>TOTAL</b>
<b>GIR</b>	44	6	3	15	<b>68</b>
<b>PC</b>	3	28	27	7	<b>65</b>
<b>ELR</b>	-	8	6	2	<b>16</b>
<b>PE</b>	-	3	12	15	<b>30</b>
<b>Total</b>	<b>47</b>	<b>45</b>	<b>48</b>	<b>39</b>	<b>179</b>



### **ELECTIVES (CHOICES)**

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

<b>Program Electives</b>	<b>Open Electives</b>	<b>Total</b>
3	7	10
4	6	10
5	5	10
6	4	10
7	3	10
8	2	10
9	1	10
10	0	10

To get degree in Civil Engineering, and minor in other programmes, possible choices of electives in Programme Electives, Open Electives and Specific programme Minor Electives are,

<b>Program Electives</b>	<b>Open Electives</b>	<b>Minor Electives</b>	<b>Total</b>
3	2	5	10
4	1	5	10
5	-	5	10



## **PROGRAMME CORE (PC)**

### **MAIR33 PROBABILITY, STATISTICS AND LINEAR PROGRAMMING**

#### **Course Learning Objectives**

1. To understand the concepts of Probability, Statistics and Linear Programming which arise in engineering applications
2. To study the defects arising in any of the engineering products
3. To study the quality of the components purchased for the projects
4. To study the optimization techniques for various problems
5. To study the Transportation and Assignment problems

#### **Course Content**

Total, Compound, Marginal and conditional probability, Bayes' theorem - Binomial, Poisson and Normal distributions, Moment generating function, Characteristic function

Central Limit Theorem, Law of large numbers, Tests of significance, large and small samples, t- test, F-test and chi-square test for goodness of fit.

Estimation theory, ANOVA table and analysis, Multiple and partial correlation - Regression

Convex spaces, LPP statement, basic feasible solution, Graphical solution - Slack and surplus variables - Artificial variable technique - Charne's penalty method - Two phase method - Dual simplex method - Primal dual problems, Transportation and Assignment problems.

Integer programming - Gomory's cutting plane method - Branch and bound method

#### **References**

1. Gupta. S.C. and Kapoor. V.K., *Fundamentals of Mathematical Statistics, 7<sup>th</sup> Edition, Sultan Chand and Sons, 1980.*
2. Kantiswarup, Gupta P.K. and Man Mohan, *Operations Research, 11<sup>th</sup> Edition, Sultan Chand and Sons, 2003.*

#### **Course outcomes**

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

1. apply the principles and techniques learnt in this course for solving the practical problems which arise in the industry
2. use Estimation Theory and Regression Analysis to estimate the present condition from previous history in any real life situation
3. apply LPP to Transportations problems which is essential for a Civil Engineer
4. apply Probability in Reliability and life testing machine tools in Civil Engineering
5. solve the Linear Programming problems for minimizing the project cost and maximizing its profit

### **MAIR41 NUMERICAL TECHNIQUES**

#### **Course Learning Objectives**

1. To study various numerical techniques



2. To study the behaviour of the solution of linear/non-linear differential equations
3. To study the solution of heat conduction/ wave equation numerically
4. To find approximate solutions with minimum error
5. To learn algorithms for computers to solve problems in math, science and engineering

### Course Content

Solution of linear system - Gaussian elimination and Gauss-Jordan methods - LV - decomposition methods - Crout's method - Jacobi and Gauss-Seidel iterative methods sufficient conditions for convergence - Power method to find the dominant eigenvalue and eigenvector

Solution of nonlinear equation - Bisection method - Secant method - Regula falsi method - Newton- Raphson method for  $f(x) = 0$  and for  $f(x,y) = 0, g(x,y) = 0$  - Order of convergence - Horner's method - Graeffe's method - Bairstow's method.

Newton's forward backward and divided difference interpolation - Lagrange's interpolation - Numerical Differentiation and Integration - Trapezoidal rule - Simpson's 1/3 and 3/8 rules - Curve fitting - Method of least squares and group averages.

Numerical Solution of Ordinary Differential Equations- Euler's method - Euler's modified method - Taylor's method and Runge-Kutta method for simultaneous equations and 2<sup>nd</sup> order equations - Multistep methods - Milne's and Adams' methods.

Numerical solution of Laplace equation and Poisson equation by Liebmann's method solution of one dimensional heat flow equation - Bender - Schmidt recurrence relation Crank - Nicolson method - Solution of one dimensional wave equation.

### References

1. *Gerald, C.F., and Wheatley, P.O., Applied Numerical Analysis, Mis. Addison Wesley, 1989.*
2. *Jain, M.K., Iyengar, S.R., and Jain, R.K., Numerical Methods for Scientific and Engineering Computation, Wiley Eastern, 1991.*
3. *Kandasamy, P.Thilagavathy, K., and Gunavathy,S., Numerical Methods, Chand and Co., 1997.*

### Course outcomes:

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

1. solve linear and non-linear equations using numerical techniques
2. solve linear and non-linear differential equations using numerical techniques
3. solve a system of equations using the techniques studied

## CEPC10 ENGINEERING MECHANICS

### Course Learning Objectives

1. To explain the importance of mechanics in the context of engineering and conservation equations.



2. To explain the significance of centroid, centre of gravity and moment of inertia.
3. To introduce the techniques for analysing the forces in the bodies.
4. To analyze the internal member forces acting on cables and trusses.
5. To understand the basic principles of dynamics.

### **Course Content**

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

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

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

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

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

### **References**

1. Kumar, K. L., Kumar, V. *Engineering Mechanics*, Pub.: Tata McGraw Hill, 2011.
2. Rajasekaran S and Sankarasubramanian G., "Engineering Mechanics Statics and Dynamics", 3<sup>rd</sup> Edition, Vikas Publishing House Pvt. Ltd., 2005.
3. Timoshenko, S. and Young, D. H., *Engineering Mechanics*, Pub.: McGraw Hill, 2006.
4. Popov, E. P., *Engineering Mechanics of Solids*, Pub.: Prentice Hall, 1998.
5. Shames, I. H. and Rao, G. K. M., *Engineering Mechanics – Static and Dynamics*, Pub.: Pearson Education, 2009.
6. Beer, F. P., and Johnson Jr. E. R., *Vector Mechanics for Engineers*, Pub.: McGraw Hill, Year of publication: 2009.

### **Course Outcomes**

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

1. identify and analyze the problems by applying the fundamental principles of engineering mechanics
2. Proceed to research, design and development of various engineering systems.

## **CEPC11 STRENGTH OF MATERIALS**

### **Course Learning Objectives**

1. To learn about the concept of stress, strain and deformation of solid and state of stress
2. To know the concepts of strain energy, principal stress and principal planes



3. To learn the bending moment, shear force and the corresponding stress distribution for different types of beams
4. To learn the analysis of plane truss, thin cylinders and shells
5. To understand the theory of torsion and stresses in springs

### **Course Content**

Tension, compression and shear stresses - Hooke's law - elastic constants - compound stresses - composite bars - thermal stresses.

Strain Energy due to axial force - Resilience - stresses due to impact and suddenly applied load - Principal stress and principal planes - Mohr's circle

Beams and support conditions -Types of supports and loads - shear force and bending moment - their diagrams for simply supported beams, cantilevers and overhanging beams. Theory of simple bending - Stress distribution at a cross section due to Bending Moment and Shear - strain energy.

Analysis of plane truss - Method of joints - Method of sections - Thin cylinders and shells.

Theory of torsion - Torsion of circular and hollow circular shafts and shear stresses due to torsion - closed and open coiled helical springs - leaf spring.

### **References**

1. *Vazirani, V.N. and Ratwani, N.M., Strength of Materials, Vol I, Khanna Publishers, 1996.*
2. *Kazimi, Mechanics of Solids, Tata McGraw - Hill, 2004.*
3. *Timoshenko, S.P. and Gere, J.M., Mechanics of Materials, Tata McGraw Hill, 1992.*

### **Course outcomes**

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

1. determine the strength parameters of the materials
2. solve principal stress and principal plane problems
3. apply various methods of analysis of plane truss
4. determine shear force, bending moment, bending and shear stress distribution
5. analyze members subjected to torsion

## **CEPC12 MECHANICS OF FLUIDS**

### **Course Learning Objectives**

1. To understand the properties of fluids and fluid statics.
2. To solve kinematic problems such as finding particle paths and stream lines.
3. To use important concepts of continuity equation, Bernoulli's equation and turbulence, and apply the same to problems.
4. To study about specific speed and performance characteristics of different types of turbines.



5. To study types of centrifugal Pumps, work done and efficiency of the different types centrifugal pumps and also study about performance of pumps & characteristic curves.

### **Course content**

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

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

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

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

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

### **References**

1. *Nagaratnam, S., Fluid Mechanics, Khanna Publishers, 1995.*
2. *Natarajan, M.K. Principles of Fluid Mechanics, Oxford & IBH Publishing Co, 1994.*
3. *JagdishLal, Hydraulics and Fluid Mechanics, Tata McGraw Hill, 2001.*
4. *Streeter V.L., Fluid mechanics, Tata McGraw Hill, 1998.*

### **Course outcomes**

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

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



## CEPC13 ENVIRONMENTAL ENGINEERING – I

### Course Learning Objectives

1. To make the students conversant with sources of water and its demand
2. To understand the basic characteristics of water and its determination
3. To expose the students to understand components of water supply lines
4. To provide adequate knowledge about the water treatment processes and its design
5. To have adequate knowledge on distribution network and water supply to buildings

### Course Content

Physical, chemical and biological characteristics of water – Water analysis – IS and WHO standards – Requirements of water supply – Types of demand and their contribution – Rate of consumption – Forecasting the population – Variation in demand pattern. Sources of water – Quantitative and qualitative studies. Intakes – Channels and pipes for conveying water – Pipes – Hydraulic design of pressure pipe – Materials – Laying – Joining – Testing – Pipe appurtenances – Pumps and pumping stations. Treatment plants – Process of treatments – Mixing, aeration, sedimentation, coagulation, filtration, disinfection, softening – Advanced water treatment. Distribution systems – Analysis of distribution networks. Operation and maintenance of water supply to buildings – Rural water supply – Protected water supply – Saline water intrusion.

### References

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

### Course Outcomes

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

1. analyze various water quality parameters
2. forecast the population and estimate water demand
3. differentiate various intake structures and select suitable pipe material for water conveyance
4. design various water treatment units and distribution network

## CEPC14 SURVEYING

### Course Learning Objectives

1. To understand the importance of surveying in the field of civil engineering
2. To get introduced to different plane and geodetic surveying applications such as chain, compass, plane table, leveling, triangulation, trigonometric leveling etc





3. To understand the significance of each method in civil engineering and master the skill to carry out the proper surveying method in the field.
4. To design numerical solutions for carrying out surveying in civil engineering field.
5. To get introduced to modern advanced surveying techniques involved such as remote sensing, Total station, GPS etc.

### **Course content**

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

Plane Table surveying – instruments and accessories – methods of plane tabling - Levelling – Levelling instruments – Temporary and permanent adjustments – Booking – Reduction to levels – Correction for Curvature and refraction

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

Geodetic surveying - Triangulation – different networks – orders and accuracies – intervisibility and height of stations – Trigonometrical levelling – Observations for heights and distances – Geodetic observations

Application of surveying - Curve setting – Types – Setting out of buildings, culverts, tunnels - Introduction to Advanced Surveying equipments - EDM – Total station - Remote Sensing – GPS

### **References**

1. Duggal, S.K. Surveying Vol. I and II, Tata McGraw Hill, 2004.
2. Punmia, B.C. Surveying Vol.I and II, Standard Publishers, 1994.
3. Arora, K. R. Surveying Vol. I and II, Standard Book House, 1996.
4. Arora, K. R. Surveying Vol. I and II, Standard Book House, 1996.
5. Satheesh Gopi. Advanced Surveying, Pearson Education, 2007.
6. Satheesh Gopi. The Global Positioning System and Surveying using GPS, Tata McGraw, 2005.

### **Course Outcomes**

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

1. to plan a survey, taking accurate measurements, field booking, plotting and adjustment of traverse can be understood through leveling, plane table surveying etc
2. Understanding of fundamental function, use of Theodolite and tacheometry in practical applications such as road alignment, height of building, control point setting etc, g with respect to utility and precision through the use of Theodolite, tacheometry
3. To understand the concepts of geodetic surveying in plan a large scale survey
4. To use the principles of curve, building setting and understand the importance of advances surveying measurement techniques in civil engineering applications.



## CEPC15 CONCRETE TECHNOLOGY

### Course Learning Objectives

1. To understand the properties of ingredients of concrete
2. To study about the concrete design mix
3. To study the behaviour of concrete at its fresh and hardened state
4. To know about the procedures in concreting
5. To understand special concrete and their use

### Course Content

Introduction - Concrete materials - Cement: Physical tests on cement - Concrete materials - Tests on aggregates - Quality of Water for mixing and curing - use of sea water for mixing concrete - Mineral and chemical Admixtures.

Mix Design - factors influencing mix proportion - Mix design by ACI method and I.S. code method.

Batching - Mixing -Transportation - Placing of concrete - curing of Concrete. Fresh and hardened properties of Concrete - Quality control - Sampling and testing- Acceptance criteria.

Creep, Shrinkage and temperature effects of concrete - durability of concrete - permeability of concrete - Corrosion - Causes and effects - remedial measures- Fire resistance of concrete – Rebound hammer and Ultra-sonic pulse velocity testing methods.

Special Concrete – Lightweight concrete - Fibre reinforced concrete - Polymer concrete - Ferro cement -Ready mix concrete- High Performance Concrete - Self compacting concrete – Sustainability of concrete.

### References

1. *Shetty, M.S., Concrete Technology (Theory & Practice), S. Chand and Co, Revised edition, 2015.*
2. *Gambhir, M.L., Concrete Technology, Tata McGraw Hill, fifth edition, 2013.*
3. *Neville A.M., Properties of Concrete, Pearson India, fifth edition.*
4. *Nevillie A.M. and J.J. Brooks, Concrete Technology, Pearson Education India Ltd.*

### Course outcomes

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

1. test all the concrete materials as per IS code
2. design the concrete mix using ACI and IS code methods
3. determine the properties of fresh and hardened of concrete
4. ensure quality control while testing/ sampling and acceptance criteria
5. design special concretes and their specific applications

## CEPC16 MECHANICS OF SOLIDS

### Course Learning Objectives:

1. To understand the concept of Principle of virtual work
2. To study the different methods of finding deflection of beam



3. To analyze the Indeterminate beams subjected to various loading
4. To study the different methods to find the deflection of truss
5. To analyze the column with different end conditions and stress in thick cylinders

### **Course Content**

Principle of virtual displacement and virtual forces - Castigliano's first theorem - Maxwell's reciprocal theorem. Determination of deflection curve of beams- double integration - Macaulay's method - Area moment method - Conjugate beam method - strain energy and dummy unit load approaches to deflection of Simple and Curved members. Statically indeterminate Structures - Propped cantilever, fixed and continuous beams - Theorem of three moments - Bending moment and shear force diagrams

Thick cylinders - Lamé's equation - Shrink fit - compound cylinders.

Deflection of trusses - Dummy unit load method - Strain energy method - Williot Mohr's diagram

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

### **References**

1. Vazirani, V.N. and Ratwani, N.M. *Strength of Materials, Vol. II, Kanna Publishers, 1996.*
2. Timoshenko, S.P. and Gere, J.M. *Mechanics of Materials, Tata McGraw Hill, 1992*
3. Rajput R.K., *Strength of Materials, S. Chand & Co., Ltd., 1996.*

### **Course outcomes**

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

1. apply the principle of virtual work
2. determine deflection of a beam for various loading conditions
3. apply unit load method to find the deflection of truss
4. determine different stresses developed in thick cylinders
5. visualize the behavior of column for combined bending and axial loading

### **CEPC17 HYDROLOGY AND WATER RESOURCES ENGINEERING**

#### **Course Learning Objectives**

1. To build on the student's background in hydrology and hydraulics an understanding of water resources systems.
2. To develop the skills in modelling of flood flows and flood routing
3. To develop skills in the ground water flow, type of aquifer and yield from the well.
4. To provide the knowledge of design of reservoir, operation and sedimentation.



### **Course content**

Hydrologic cycle - rainfall and its measurement - Precipitation circulation - temperature - Humidity – wind formation and forms of precipitation - Interpretation of precipitation data - snow cover and snow fall. Factors affecting and methods of determining evaporation, infiltration and Evapotranspiration.

Runoff -infiltration indices - Storm Hydrograph and unit hydrograph - Derivation of unit hydrograph from complex storms - unit hydrographs for various duration - Synthetic unit hydrograph - Transposing unit hydrograph - Application of the unit hydrograph – GIUH – Nash Model.

Flood Modelling - Flood routing – Hydrologic routing – Reservoir routing – Modified puls method – good rich method – Channel routing – Muskingum cungethmethod.

Design storm – Design Flood – PMP – PMF - Logpearson type II distribution – Gumbels' distribution –Linear Regression models in hydrology – Basics of Reservoir Operation

Reservoir planning - Investigations - zones of storage in a reservoir - single purpose and multipurpose reservoir - determination of storage capacity and yield - reservoir sedimentation - Reservoir life – sediment prevention

### **References**

1. *Punmia, B.C., Irrigation and Water Power Engineering, Standard Publishers, 2001.*
2. *Ragunath. H.M., Hydrology, Willey Eastern Limited, New Delhi, 2000.*
3. *Subramanya, Engineering Hydrology, Tata-McGraw Hill, 2004.*

### **Course outcomes**

By the end of this course the students

1. Incorporate the analytical abilities in the planning and design of water resource systems.
2. Acquire the knowledge on reservoir planning and investigation.
3. Acquire fundamentals of water logging, soil salinity and land reclamation.
4. Understand the basics for the study of surface water flows.

## **CEPC18 ENVIRONMENTAL ENGINEERING-II**

### **Course Learning Objectives**

1. To learn the basics of sewage composition and its characteristics
2. To have adequate knowledge about various sewage treatment processes and its design
3. To provide the adequate information on various disposal standards for industrial effluents
4. To study the effect of air pollution and its control measures
5. To gain knowledge about solid waste disposal and Environmental Impact Assessment

### **Course Content**

Characteristics and composition of sewage – Sampling – Analysis – Population equivalent – Drainage in buildings – Plumbing systems for drainage. Primary



treatment – Secondary treatment – Biokinetics – Lagooning – Sludge digestion – Tertiary treatment. Disposal standards – Self-purification of rivers – Streeter Phelps equation – Oxygen sag curve. Toxic and hazardous wastes – Equalization and neutralization – Biological degradation – Recycle and reuse of waste effluents – Treatment of industrial wastewater – Dairy, Tannery, Petrochemical, Fertilizer, Textiles, Pulp and paper. Air pollution – Effects – Stack emission – Automobile exhaust – Control devices – Solid waste management – Environmental Impact Assessment.

### References

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

### Course Outcomes

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

1. determine the various characteristics of sewage
2. design various sewage treatment units
3. predict the quality of water in river, using mass balance approach and specific models
4. select suitable treatment units for specific industries
5. identify the sources of air pollutants, effects on human health and the environment

## CEPC19 GEOTECHNICAL ENGINEERING-I

### Course Learning Objectives

1. To explain how three phase system is used in soil and how are soil properties estimated using three phase system
2. To explain the role of water in soil behaviour and how soil stresses, permeability and quantity of seepage including flow net are estimated
3. To emphasis the importance of soil stress distribution and stress influence due to varies loads.
4. To explain how soil shear parameters are affected by drainage conditions
5. To estimate the magnitude and time-rate of settlement due to consolidation

### Course content

Historical development of Soil Engineering - Origin and general types of soils - soil structure, clay minerals-Three phase system- Identification and Classification of soils.



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

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

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

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

### References

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

### Course Outcomes

Upon completion of this course, the students will be able to

1. Understand the importance of geotechnical engineering in civil engineering and do proper soil classification and three phase system to solve the problems
2. Solve any practice problems related to soil stresses estimation, permeability, seepage including flow net diagram.
3. Do proper stress estimation under any system of foundation loads
4. Estimate appropriate soil strength parameters with respect to the drainage conditions
5. Solve any practical problems related to consolidation like consolidation settlement, time rate of settlement



## CEPC20 HIGHWAY AND PAVEMENT ENGINEERING

### Course Objectives

1. To understand the importance of transportation, characteristics of road transport, highway planning, alignment and surveys
2. To know the geometric design of highways
3. To study the traffic characteristics and principles of intersection design
4. To know about the pavement materials and design
5. To understand the pavement construction, distresses in pavements and maintenance options
6. To learn the characteristics, properties and testing procedures of aggregate and bitumen

### Course Content

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

**Highway Geometric Design:** Factors affecting geometric design. Sight distance - stopping sight distance, overtaking sight distance, sight distance at intersections. Design of horizontal alignment - super elevation, widening of pavements, transition curves. Design of vertical alignment - gradients, summit and valley curves.

**Traffic Engineering:** Road user, vehicle and traffic characteristics – Speed, volume, parking and accident studies. Concepts of PCU, capacity and level of service. Traffic signs and road markings - objectives, classification and uses. Principles of design of at-grade intersections – channelized, rotary and signal intersections. Introduction to grade separated intersections.

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

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

### Pavement Laboratory

#### Tests on aggregate

1. Specific Gravity
2. Sieve Analysis
3. Water Absorption
4. Shape Test- Flakiness Index
5. Shape Test- Elongation Index
6. Aggregate Impact Value



7. Aggregate Crushing Value
8. Los Angeles Abrasion Test

#### **Tests on bitumen**

9. Specific Gravity
10. Penetration Grade
11. Softening Point
12. Ductility Value
13. Flash and Fire Point
14. Viscosity Value

#### **Mix design**

15. Granular Sub-base
16. Bituminous Layer

#### **Pavement Condition Evaluation**

17. Measurement of Rutting, Raveling, Edge drop, Potholes, Cracking, Longitudinal Depression, Patching, Drainage parameters etc.
18. Demonstration of DCP, BBD, MERLIN, Roughometer, Geogauge etc.

#### **References**

1. Khanna, S. K., Justo, C. E. G. and Veeraragavan A., Highway Engineering, Nem Chand and Bros, Roorkee, 2014.
2. Kadiyali, L. R., and Lal, N. B., Principles and Practices of Highway Engineering, Khanna Publishers, 2008.
3. Huang, Y. H. Pavement Analysis and Design, Pearson Prentice Hall, New Jersey, USA, 2004.
4. Relevant IRC Codes of Practices
5. Ministry of Road Transport and Highways, Specifications for Road and Bridge Works, Indian Roads Congress 2004

#### **Course Outcomes**

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

1. carry out surveys involved in planning and highway alignment.
2. design sight distances, horizontal and vertical alignments.
3. carry out traffic studies and intersection design.
4. determine the characteristics of pavement materials and design of pavements
5. measure and analyse distresses and recommend maintenance strategies.

### **CEPC21 ANALYSIS OF INDETERMINATE STRUCTURES**

#### **Course Learning Objectives**

1. To understand the concept of analysis of indeterminate structures by various classical methods
2. To study the use of ILD for determinate structure
3. To learn the concepts of moving loads and its effect on structures





4. To understand the concept of equivalent UDL
5. To study the reversal of stress under live load

### **Course Content**

Slope deflection method - analysis of indeterminate structures- Settlement.

Moment distribution method - analysis of indeterminate structures - settlement of supports - sway.

Energy methods - Kani's method - analysis of indeterminate structures - settlement of supports - sway.

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

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

### **References**

1. Jindal. R.L, *Indeterminate Structures, Chan Tea, New Delhi, 2000*
2. Punmia B.C., *Theory of Structures, Standard Book House, New Delhi, 2000*

### **Course outcomes**

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

1. use various classical methods for analysis of indeterminate structures
2. determine the effect of support settlements for indeterminate structures
3. apply the concepts of ILD and moving loads on determinate structures
4. apply the concept of equivalent UDL
5. determine the reversal of stresses in trusses using ILD

## **CEPC22 BASIC REINFORCED CONCRETE DESIGN**

### **Course Learning Objectives**

1. To study the stress strain behavior of steel and concrete
2. To understand the concept of working stress and limit state methods
3. To gain the knowledge of limit state design for flexure, shear, torsion, bond and anchorage
4. To understand the behavior of columns subjected to eccentric load and use of interaction diagrams
5. To study the design of various foundation

### **Course Content**

Stress strain behavior of steel and concrete- Introduction to working stress method - permissible stresses. Limit state method-Limit states - Characteristic strength and load - Partial safety factor - Design of singly and doubly reinforced beams, T and L beams - Design for Shear and Torsion. Slabs - one way and two way slabs for different edge conditions - Yield line theory - Flat slab - continuous slabs - stair cases - different types. Columns - axially loaded and eccentrically loaded columns -



Interaction Diagrams. Footings - isolated footings - square, rectangular and circular footings - Combined footing Pile and pile cap- Introduction to masonry structures.

**Note:** Assignments include the design and drawings of various R.C.C structural elements.

### References

1. Ashok, Kumar Jain, *Reinforced Concrete Limit State Design*, Nem Chand Brothers, 1990.
2. Sinha. S.N. *Reinforced Concrete Design*, Tata McGraw Hill, 2002.
3. Varghese, *Limit state design of concrete*, Oxford IBH, 2000.
4. IS456-2000 *Code of practice for Plain and reinforced concrete code of practice*.

### Course outcomes

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

- apply the fundamental concepts of working stress method and limit state method
- use IS code of practice for the design of concrete elements
- design the beams, slab, stairs, column and footing
- draw various RCC structural elements
- design masonry structures

## CEPC23 GEOTECHNICAL ENGINEERING-II

### Course Learning Objective

1. To emphasize the importance of soil investigations including destructive and non-destructive methods.
2. To explain how earth pressure theory is important in retaining structure design
3. To explain the concept of bearing capacity and how to estimate the safe bearing capacity for various foundation system including settlement consideration
4. To explain how to select a suitable shallow foundation system for various site conditions and also analysis of different foundation system
5. To explain in what circumstances pile is needed and how to estimate pile and pile group capacity under various soil conditions

### Course content

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

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

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



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

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

### References

1. Murthy, V.N.S, A text book of Soil Mechanics and Foundation Engineering, UBS Publishers & Distributors Pvt. Ltd., New Delhi 1999.
2. Punmia, B.C., Soil Mechanics and Foundation Engineering, Laxmi Publications Pvt. Ltd., New Delhi, 1995.
3. Gopal Ranjan and Rao, Basic and Applied Soil Mechanics, New Age International (P) Limited, New Delhi, 2002.
4. Nainan P Kurian, Design of foundation Systems Principles and Practices, Narosa, 2011
5. Braja M. Das, Principles of Foundation Engineering, Thomson Asia Pvt. Ltd., Singapore, 2005.
6. Donald P. Coduto, Man-Chu Ronald Yeung and William A. Kitch, Geotechnical Engineering, Principles and Practices, PHI Learning Private limited, 2011.
7. Joseph E. Bowles, Foundation Analysis and Design, McGRAW-Hill, 1998.
8. Shenbaga R Kaniraj, Design Aids in Soil Mechanics and Foundation Engineering, Tata McGraw Hill, 2011.

### Course outcomes

Upon completion of this course, the students will be able to

1. Understand the importance of soil investigation for any civil engineering construction
2. Analysis any earth retaining structures for any kind of soil medium
3. Do proper bearing capacity estimation including IS code methods
4. Do proper foundation proportioning for any kind of shallow foundation system and also get exposed in foundation analysis
5. To estimate pile and pile group capacity for any kind of soils including group efficiency and negative friction

## CEPC24 BASIC STEEL STRUCTURAL ELEMENTS

### Course Learning Objectives

1. To understand the provisions of IS800-2007 code of practice for the design of Compression, Tension and Flexural members using various cross-sections.
2. To study the behavior and design of compression and tension members using simple and built-up sections.
3. To understand behavior of flexural members and the design laterally restrained and unrestrained beams.



4. To study the design of bolted and welded connections and arranging field visit to industries.

### Course content

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

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

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

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

Welded connections - types - strength of welds - design of fillet and butt welds - shear and moment resistant connections - design and detailing of connections.

**Note:** Assignments include the design and drawings of various steel structural elements.

### References

1. Subramanian N, *Design of Steel Structures*, Oxford University Press, New Delhi 2008.
2. Bhavikatti, S.S., *Design of Steel Structures*, I.K. International Publishing House Pvt. Ltd., New Delhi, 2010
3. Krishnaraju, N. *Structural Design and Drawing*, Universities Press, 2009
4. IS 800 - 2007, *Code of practice for general construction in steel*, Bureau of Indian Standards, New Delhi.
5. SP6 (1)-1964, *IS hand book for structural Engineers*. Bureau of Indian Standards, New Delhi.

### Course outcomes

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

1. Apply the IS code of practice for the design of steel structural elements.
2. Design compression and tension members using simple and built-up sections.
3. Calculate forces on the various members of the truss and design them.
4. Analyze the behavior of bolted connections and design them.
5. Design welded connections for both axial and eccentric forces.



## **CEPC25 ADVANCED STRUCTURAL ANALYSIS**

### **Course Learning Objectives**

1. To understand the influence line concepts for indeterminate structures
2. To understand the methods of analysis of intermediate trusses for external loads, lack of fit and thermal effect
3. To study behaviour of arches and their methods of analysis
4. To know the concept and analysis of cable stayed bridge
5. To study the multi storey frames subjected to gravity loads and lateral loads

### **Course content**

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

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

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

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

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

### **References**

1. Punmia, B.C, Theory of Structures, Laxmi Publications, 2000.
2. Timoshenko, S.P., Young, D.H., Theory of Structures, Tata McGraw Hill, 1983.
3. Wang. C.K., Intermediate Structural Analysis, International Text Book Co, 1983.
4. Hibbeler. R.C., Structural Analysis, Pearson Education (Singapore) Ptc. Ltd., Indian Branch, 2002.

### **Course outcomes**

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

1. Demonstrate the concepts of qualitative influence line diagram for continuous beams and frames.
2. Apply the methods of indeterminate truss analysis.
3. Demonstrate the behavior of arches and their methods of analysis.
4. Analyse cable suspension bridges.
5. Analyse multistory frames subjected to gravity loads and lateral loads.



## **CEPC26 ADVANCED REINFORCED CONCRETE DESIGN**

### **Course Learning Objectives**

1. To understand the design concept of various structures and detailing of reinforcements
2. To understand the design of underground and elevated liquid retaining structures
3. To study the design of material storage structures
4. To know the effect of temperature on concrete structures
5. To study the design of bridges subjected to IRC loading

### **Course Content**

Earth Retaining structures - Retaining walls- types - cantilever and counterfort - design - drainage and other construction details. Liquid Retaining structure - Water tanks - types - square, rectangular, circular - Design of underground and elevated tanks - design of staging - spherical & conical roof for circular tanks. Material storage structures - Determination of lateral pressure on side walls of bunker - Rankine's theory - design of bunker - design of circular silo using Jansen's theory. Environmental Structures - Chimneys - Principles and Design - Design of long columns. Transportation structures - Bridges - Slab bridge - Design of single span slab bridge - Tee beam bridge - Design of Tee beam bridge with stiffness - Tee beam bridge with cross girders

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

### **References**

1. Vazirani, V.N., and Ratwani, Concrete Structures, Vol. IV, Khanna Publishers, New Delhi, 1995.
2. Dayaratnam, P., Design of Reinforced Concrete Structures, Oxford & IBH Publishers & Co., New Delhi, 2005.
3. Victor, D.J., Essentials of Bridge Engineering, Oxford & IBH Publishers Co., New Delhi, 1991.
4. IS456-2006 Code of practice for Plain and reinforced concrete code of practice.

### **Course outcomes**

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

1. apply the concepts of liquid retaining structures
2. design material storage structures using various theories
3. apply the concepts of environmental and transportation structures
4. demonstrate the detailing of reinforcement
5. draw the various RCC structures

## **CEPC27 ADVANCED STEEL STRUCTURAL ELEMENTS**

### **Course Learning Objectives**

1. To study the behavior and design of member subjected to combined forces



2. To understand the analysis procedure and design of base plate subjected to different loading conditions
3. To study the design of Gantry girder, welded plate girder, stiffeners and connections.
4. To calculate the wind forces on various types of structures.
5. To understand the design of industrial buildings/bents/
6. To understand the design of moment resisting connections used in steel frames

### **Course content**

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

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

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

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

Analysis and design of framed connections.

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

### **References**

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

### **Course outcomes**

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

1. Design eccentrically loaded compression members (Beam-Columns) and their base plates.
2. Design welded plate girder and other components
3. Design Gantry girder for industrial structures



4. Calculate the wind load acting on various structures to be built in various locations.
5. Design Industrial structures and their components such as girts, wind girders, bracings systems purlins etc.

### **CEPC28 RAILWAY, AIRPORT AND HARBOUR ENGINEERING**

#### **Course Learning Objectives**

1. To know about the basics and design of various components of railway engineering.
2. To study about the types and functions of track, junctions and railway stations.
3. To learn about the aircraft characteristics, planning and components of airport.
4. To study about the types and components of docks and harbours.
5. To know about various urban transportation systems and Intelligent Transportation Systems.

#### **Course content**

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

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

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

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

Urban transportation systems - Bus transit - Mass Rapid Transit System - Light Rail Transit. Transport economics and Financing - Intelligent Transportation Systems (ITS)

#### **References**

1. *M.M. Agarwal, Railway Engineering, Prabha & Co. 2007.*
2. *Khanna, S.K. and Arora, M.G. Airport Planning and Design, Nemchand and Bros. 1999.*
3. *Oza and Oza, Elements of Dock and Harbour Engineering, Charotar Publishing House, 1996.*

#### **Course outcomes**

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

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





## CEPC29 IRRIGATION AND HYDRAULIC ENGINEERING

### Course Learning Objectives

- To understand the basic types of irrigation, irrigation standards and crop water assessment
- To study the different aspects of design of hydraulic system
- To provide knowledge on various diversion structures
- To understand the Canal Irrigation system

### Course content

Need for irrigation – Advantages and ill effects – Development of irrigation – National Water Policy – Tamil Nadu scenario - Physical properties of soil that influence soil moisture characteristics – Concept of soil water potential and its components: Gravitational, Pressure and Osmotic- Retention of water in soils and concept of plant available water – Movement of water into and within the soils – Measurement of soil moisture content and the matric tension with which it is held

Soil- Water-Plant relationship - Water as a constituent of plant – Soil-Plant-Atmosphere continuum – Terminology in plant – Water relationships (Evapotranspiration, consumptive use and crop factor) – Critical stages of crop growth for water requirement – Analysis of crop water demand: basic concepts and estimation

Canal Irrigation- Classifications of canals, canal alignment, Silt theories – Kennedy's theory, Lacey's theory, Drawbacks in Kennedy's and Lacey's theories, comparison of Lacey's and Kennedy's theories, Design of unlined canals based on Kennedy and Lacey's theories, suspended and bed loads. Lined Canals: Types of lining, design of lined canal, Losses in canals-evaporation and seepage, water logging, causes and ill effects of water logging, anti-water-logging measures.

Diversion Structures-Functions and components of a diversion head work - Function-selection of site - type of weirs on pervious foundations - cause of failure - Bligh's creep theory and Khosla's theory - complete design of a vertical drop weir.

Field Measurements, Land leveling and drainage – Irrigation methods: relative merits and limitations – Evaluation of irrigation methods –Irrigation water quality - Irrigability of soils and the irrigation related degradation of soil resource (such as water logging, salinity and sodicity) – Management of Irrigation tanks, lakes and water bodies – Rainwater harvesting and artificial recharge

Note: Assignments include the design and drawings of various irrigation structures.

### References

1. Sharma, S.K., Principles and Practice of Irrigation Engg, S.Chand & Co, 1984.
2. Arora K R "Irrigation Water Power & Water Resources Engineering" Standard Publishers & Distributors, Delhi, 2002.
3. Garg S K "Irrigation Engineering & Hydraulic Structures" Khanna Publishers, Delhi, 1995.
4. Varshney, Gupta & Gupta "Irrigation Engineering & Hydraulic Structure" Nem Chand & Bros., Roorkee, 1982.
5. Punmia, B.C., Irrigation and Water Power Engineering, Standard Publishers, 2001.



## Course outcomes

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

1. Assess the crop water requirement for various crops in the command area.
2. Understand the complete design of various Canal irrigation system.
3. Provides the knowledge in the design of diversion structures.
4. Provides knowledge of soil water relationships.
5. Establishes the understanding of land drainage system.

### **PROGRAMME ELECTIVE (PE)**

#### **CEPE10 CONSTRUCTION TECHNIQUES AND EQUIPMENTS**

### Course Learning Objectives

1. To learn the principles of construction of building components
2. To know about prefabricated construction and building services
3. To study the different repair and rehabilitation technique
4. To understand the planning and operation of various construction equipment

### Course Content

Principles of construction: Bonding , Reinforced brick work , Stone masonry, Hollow block masonry Composite masonry, Cavity walls, Flooring, Formwork, Centering and Shuttering sheet piles, Slip and moving forms, Roofs and roof covering, Joints in Concrete, Plastering and Pointing, Shoring and Scaffolding, Under pinning, Submerge Structures.

Prefabricated structures and building services: Prefabricated panels & structures, Production, Transportation and Erection of structures, Sound insulations, Ventilations, Fire resisting construction, Damp proofing, Termite proofing.

Construction damages & repair techniques: Causes of damage and deterioration in masonry and concrete structures, Symptoms & Diagnosis, Types of repair and rehabilitation techniques.

Basics of construction equipment: Factors affecting the selection of equipment, economic life of equipment, cost of equipment, maintenance of equipment.

Construction equipment and machinery: Earthwork equipment, Hoisting and lifting equipment, Material handling equipment, Concrete equipment, dewatering equipment.

### References

1. Arora, S.P. and Bindra, S.P. *A Text Book of Building Construction*, Dhanpat Rai Publications, New Delhi, 2005.
2. Varghese, P.C., *Building Constructions*, Prentice Hall, 2007.
3. Sharma & Kaul, *Building Construction*, S.Chand & Company Pvt, New Delhi, 1998
4. Peurifoy, R.L., Schexnayder, J.C., and Shapira, A, *Construction Planning, Equipment and Methods*, Tata McGraw Hill, New Delhi, 2010.
5. Sharma S.C. *Construction Equipment and Management*, Khanna Publishers, New Delhi, 2013.



### **Course outcomes**

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

1. Supervise and execute all the construction jobs with the knowledge of the different construction techniques
2. Identify the building defects and apply suitable repair techniques to rectify them
3. Evaluate the costs of equipment and make proper selection of the suitable construction equipment
4. Ensure the proper completion of a construction task using particular construction equipment

### **CEPE11 ELEMENTARY STRUCTURAL DYNAMICS**

#### **Course Learning Objectives**

1. To introduce the concepts of dynamic systems
2. To study the dynamic response of SDOF
3. To study the dynamic response of MDOF
4. To introduce the continuous systems subjected to different types of dynamic loads
6. To learn free and forced vibrations response of structural systems

#### **Course content**

Dynamic analysis - Elements of vibratory systems and Simple Harmonic Motion.

Free vibration of Single Degree of Freedom Systems; undamped and damped systems. Viscous damping and Coulomb damping. Evaluation of damping

Forced vibration of undamped and damped systems – Structures subjected to harmonic loads

Resonance condition. Dynamic Amplification Factors.

General types of loads - Duhamel's integral approach to solution.

Free vibration analysis using Rayleigh's method

Differential equation of motion – Thin Beam flexural vibration analysis – Beam functions.

Free vibration of Multi-Degree of freedom systems- Solution of the eigen value problem - Iteration due to Holzer and Stodola.

Idealization of multi-storeyed - lumped SDOF system

#### **References**

1. Mario Paz, *Structural Dynamics*, CBS, Publishers, 1987.
2. Roy R Craig, Jr., *Structural Dynamics*, John Wiley & Sons, 1981.
3. A.K. Chpora "Dynamics of Structures Theory and Application to Earthquake Engineering" Pearson Education, 2001.



## Course outcomes

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

1. Apply the concepts of dynamic systems.
2. Identify, formulate and solve dynamic response of SDOF.
3. Identify, formulate and solve dynamic response of MDOF.
4. Analyse continuous systems subjected to different types of dynamic loads.
5. Identify, formulate and solve free and forced vibrations response of structural systems.

## CEPE12 MAINTENANCE AND REHABILITATION OF STRUCTURES

### Course Learning Objectives

To provide a comprehensive knowledge on the diagnosis the damage, condition assessment of structures and quality of material application relating to maintenance and rehabilitation of structures.

### Course content

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

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

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

**Materials and Techniques:** Special concrete and mortar, concrete chemicals, expansive cement, polymer concrete sulphur infiltrated concrete, Ferro cement, fiber reinforced concrete. Methods of repair in concrete, steel and masonry structures. Guniting and shotcrete, epoxy injection.

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

### References

1. Raiker .R.N, "*Learning from Failures, Deficiencies in Design, Construction and Service*", - R&D Centre (SDCPL), Raikar Bhavan, Bombay 1987.
2. "*Repair & Rehabilitation*", *Compilation from The Indian Concrete Journal*, - ACC – RCD Publication 2001.
3. Allen .R.T, and Edwards .S.C, Shaw D.N, "*Repair of Concrete Structures*", Chapman and Hall, 2005.



### **Course outcomes**

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

1. Diagnosis the damage of distress structures
2. Investigate the condition assessment of structures
3. Select the proper repair materials and its application
4. Select the method to Strengthen the distressed structures

### **CEPE13 CONSTRUCTION MANAGEMENT**

#### **Course Learning Objectives**

1. To know the managerial duties and responsibilities
2. To learn about man power planning and estimation of equipment cost
3. To understand project planning and scheduling concepts
4. To know the types of construction contracts and their drafting
5. To learn the application of computer software in construction management

#### **Course content**

Introduction: project forms, management objectives and functions; organizational chart of a construction company; manager's duties and responsibilities; public relations; Leadership and team - work; ethics, morale, delegation and accountability.

Man and Machine: Man-power planning, training, recruitment, motivation, welfare measures and safety laws; machinery for Civil Engineering., earth movers and hauling costs, factors affecting purchase, rent, and lease of equipment, and cost-benefit estimation.

Planning, scheduling and Project Management: Planning stages, construction schedules and project specification, monitoring and evaluation; Bar-chart, CPM, PERT, network- formulation and time computation.

Contracts: Types of contracts, Formation of contract – Contract conditions – Contract for labour, material, design, construction – Drafting of contract documents based on IBRD/ MORTH Standard bidding documents – Construction contracts – Contract problems – Arbitration and legal requirements

Computer applications in construction management: Software for project planning, scheduling and control.

#### **References**

1. *Dharwadkar, P.P., Management in Construction Industry, Oxford IBH, New Delhi, 1992.*
2. *Patrick, C., Construction Project Planning and Scheduling, Pearson, 2012.*
3. *Brien, J.O. and Plotnick, F.L., CPM in Construction Management, Mcgraw Hill, 2010.*
4. *Punmia, B.C., and Khandelwal, K.K., Project Planning and control with PERT and CPM, Laxmi Publications, 2002.*

#### **Course outcomes**

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



1. Perform the role of a manager efficiently with precise knowledge of the roles and responsibilities
2. Estimate the man power requirement and can recruit suitable candidates for construction jobs
3. Analyse and compare the cost estimates of different construction equipment
4. Compute construction schedules, network diagrams and time estimates of projects
5. Evaluate and make tenders and contract documents of their own
6. Use the computer software to monitor real-time projects

### **CEPE14 STRUCTURAL SYSTEM ANALYSIS**

#### **Course Learning Objectives**

1. To understand the importance of degrees of freedom and the concept of principle of superposition
2. To know about the concept of strain energy and principle of virtual work
3. To study the transformation of system matrices and element matrices for the determinate and indeterminate structures
4. To analyze the forces in structures like continuous beam, truss and frames using stiffness and flexibility method
5. To understand the behaviour of structures due to thermal expansion and lack of fit

#### **Course Content**

Generalized measurements - Degrees of freedom - Constrained Measurements - Behavior of structures - Principle of superposition. Stiffness and flexibility matrices - Constrained measurements - Stiffness and flexibility coefficients from virtual work.

Strain energy - Stiffness and flexibility matrices from strain energy - Symmetry and other properties of stiffness and flexibility matrices - Betti's law and its applications - Strain energy in systems and in elements.

Determinate and indeterminate structures - Transformation of element matrices to system matrices - Transformation of system vectors to element vectors - Normal coordinates and orthogonal transformations.

Flexibility method applied to statically determinate and indeterminate structures - Choice of redundants - Transformation of redundants - Internal forces due to thermal expansion and lack of fit.

Development of the method - Internal forces due to thermal expansion and lack of fit - Application to symmetrical structures - Comparison between stiffness and flexibility methods.

#### **References**

1. *Moshe, F., Rubenstein, Matrix Computer Analysis of Structures, Prentice Hall, New York, 1986.*
2. *Rajasekaran S, Computational Structural Mechanics, Prentice Hall of India, New Delhi, 2001*



3. *Manickaselvam V.K., Elements of Matrix and Stability Analysis of Structures, Khanna Publishers, New Delhi, 1998.*

### **Course outcomes**

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

1. apply the basic concepts of matrix methods in structural analysis
2. develop stiffness and flexibility matrices
3. analyze the structures using flexibility and stiffness method
4. transform system coordinates to element coordinates
5. determine the forces in various members due to lack of fit and thermal expansion

## **CEPE15 PRESTRESSED CONCRETE STRUCTURES**

### **Course Learning Objectives**

1. To learn the principles, materials, methods and systems of prestressing
2. To know the different types of losses and deflection of prestressed members
3. To learn the design of prestressed concrete beams for flexural, shear and tension and to calculate ultimate flexural strength of beam
4. To learn the design of anchorage zones, composite beams, analysis and design of continuous beam
5. To learn the design of water tanks

### **Course Content**

Principles of prestressing - Materials of prestressing - Systems of prestressing - Loss of prestress - Deflection of Prestressed Concrete members.

Slabs - Pre-tensioned and Post-tensioned beams - Design for flexure, bond and shear - IS code provisions - Ultimate flexural and shear strength of prestressed concrete sections - Design of end anchorage zones using IS code method.

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

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

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

### **References**

1. *Lin. T.Y., Burns, N.H., Design of Prestressed Concrete Structures, John Wiley & Sons, 1982.*
2. *RajaGopalan N. Prestressed Concrete, Narosa Publishing House, New Delhi, 2002.*

### **Course outcomes**

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

1. design a prestressed concrete beam accounting for losses
2. design the anchorage zone for post tensioned members



3. design composite members
4. design continuous beams
5. design water tanks

## **CEPE16 STEEL STRUCTURAL SYSTEMS**

### **Course Learning Objectives**

1. To learn the analysis and design procedure of various types of steel stacks
2. To learn the analysis and design procedure of steel towers and masts
3. To learn the analysis and design procedure of moment resisting steel frames for gravity and lateral loads
4. To learn the analysis and design procedure of steel bunkers and silos
5. To learn the analysis and design procedure of various types of steel water tanks and their staging.

### **Course content**

Analysis and design of steel stacks - functional and structural requirements – self – supporting, guyed and derrick tower supported stacks - base plate and anchor bolt.

Towers and masts – lattice tower configurations and bracings – loads on lattice towers – analysis and design of lattice towers – transmission line towers – foundation for towers.

Multi-storey buildings – analysis using approximate methods – design structural systems for gravity and lateral load.

Design of steel bunkers and silos – janssen’s theory – Airy’s theory – design parameters – design criteria – analysis of Bins – Hopper bottoms – design of bins

Design of steel tanks – types of tanks – elevated circular/rectangular tanks – stresses in spherical / conical bottom – circular girder – staging for circular/rectangular tanks.

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

### **References**

1. Subramanian N, *Design of Steel Structures*, Oxford University Press, New Delhi 2008.
2. Dayaratnam, P., *Design of Steel Structures*, S. Chand & Company LTD, New Delhi, 2003
3. Ram Chandra and Virendra Gehlot, *Design of Steel Structures, Vol. I*, Standard Book House, New Delhi
4. Ram Chandra and Virendra Gehlot, *Design of Steel Structures, Vol. II*, Scientific Publishers, New Delhi
5. IS 800 - 2007, *Code of practice for general construction in steel*, Bureau of Indian Standards, New Delhi.

### **Course outcomes**

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

1. Design various types of steel stacks





2. Design steel towers and masts
3. Design moment resisting steel frames for gravity and lateral loads
4. Design steel bunkers and silos
5. Design steel water tanks and their staging

## **CEPE17 STEEL CONCRETE COMPOSITE STRUCTURES**

### **Course Learning Objectives**

1. To introduce the concept of composite construction and their applications in engineering
2. To discuss shear connector types, degree of shear connector, interaction and their strength
3. To introduce design of composite beams under propped and un-propped condition
4. To introduce design of different types of composite deck slabs
5. To discuss effects of temperature, shrinkage and creep and cyclic loading on composite sections

### **Course content**

Introduction – types – advantages – comparison – applications - limit states of composite sections – introduction to plastic analysis – mechanism of composite members.

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

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

Design of composite beam with profile sheet – propped and un-propped condition – deflection of composite beams – design of partial shear connection.

Introduction – Composite slabs – profiled sheeting – sheeting parallel to span – sheeting perpendicular to span – analysis and design of composite floor system.

### **References**

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



### **Course outcomes**

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

1. Apply the concepts of composite construction in engineering.
2. Analyse the behavior of shear connectors, degree of shear connection and their interaction.
3. Design composite beams under propped and un-propped condition.
4. Design different types of composite deck slabs.
5. Analyse the effects of temperature, shrinkage and creep and cyclic loading on composite sections.

### **CEPE18 EARTHQUAKE RESISTANT STRUCTURES**

#### **Course Learning Objectives**

1. To introduce the basics of Earthquake Engineering
2. To introduce the engineering seismology, building geometrics & characteristics, structural irregularities,
3. To introduce tips on earthquake engineering - do's and don'ts
4. To introduce cyclic loading behaviour of RC, steel and pre-stressed concrete elements
5. To discuss code provisions and their application on different types of structures

#### **Course Content**

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

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

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

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

Seismic performance - Irregular Buildings -Soil performance, Modern Concepts - Base Isolation - Adoptive systems - Case studies.

#### **References**

1. *Pankaj Agarwal and Manish ShriKhande, Earthquake Resistant Design of Structures, Prentice- Hall of India, New Delhi, 2003.*
2. *Bullen K.E., Introduction to the Theory of Seismology, Great Britain at the University Printing houses, Cambridge University Press 1996.*

### **Course outcomes**

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

1. apply the basics of Earthquake Engineering
2. demonstrate the dynamics of structural system under earthquake load
3. analyze the influence of the structural / geometrical design in building characteristics



4. demonstrate the cyclic loading behaviour of RC steel and pre-stressed concrete elements
5. apply Codal provisions on different types of structures

### **CEPE19 TRAFFIC ENGINEERING AND SAFETY**

#### **Course Learning Objectives**

1. To understand the fundamentals of traffic stream characteristics
2. To learn the skills of traffic control and management
3. To learn the methods of safe intersection design
4. To learn the importance and methods of accident investigation and prevention
5. To understand the concepts of road safety audit and safety improvement methods

#### **Course Content**

Traffic stream characteristics: Road user, vehicle and highway characteristics, Fundamental parameters and relations of traffic flow, Traffic stream models. Speed data collection and analysis, Density and travel time measurement and analysis, Moving Observer Method, Automated Traffic Measurements - Traffic forecasting and growth studies. Capacity and level of services of roads. Pedestrian studies – flow characteristics - Design principles of pedestrian facilities.

Traffic Management: Parking studies – parking statistics, parking surveys, parking requirements - on street and off street parking. Lay-byes and bus stops. Principles of Traffic Control: Basics of traffic management. Traffic Signs, Road Markings. Traffic System Management – speed, vehicle, parking, enforcement regulations. Mixed traffic regulations – one way, tidal flow, turning restrictions etc.

Design of Intersections for Safety: Uncontrolled intersection, Conflicts at intersection, Channelization, Traffic islands, Design of median islands, turning vehicle templates. Traffic intersection control: Traffic Rotaries – design of traffic rotaries. Traffic signal design - Design Principles of Traffic Signal, Coordinated Traffic Signal, Vehicle Actuated Signals and Area Traffic Control. Design of Grade Separated Intersection - trumpet, diamond, cloverleaf and flyovers.

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

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

#### **References**

1. *Khanna, S. K., Justo, C. E. G. and Veeraragavan A., Highway Engineering, Nem Chand and Bros, Roorkee, 2014.*
2. *Kadiyali, L. R., and Lal, N. B., Principles and Practices of Highway Engineering, Khanna Publishers, 2008.*
3. *IRC SP: 88 – 2010*



4. *Rune Elvik, Alena hoye, Truls Vaa and Michael Sorensen, The handbook of Road Safety Measures, Emerald Group Publishing Limited, 2009*
5. *ITE, Highway Safety Manual, ITE, 2010*

### **Course Outcomes**

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

1. Carry out traffic surveys
2. Implement traffic system management
3. Carry out intersection design for safety
4. Record and analyse accident data and suggest countermeasures
5. Carry out road safety audit

## **CEPE20 PAVEMENT ANALYSIS AND DESIGN**

### **Course objectives**

1. To study about the types and components of pavements
2. To learn about the stresses in flexible pavements and equivalent single wheel load
3. To study the design of flexible pavements
4. To learn about the stresses in rigid pavements
5. To study the design of rigid pavements

### **Course content**

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

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

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

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

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

### **References**

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



## Course outcomes

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

1. Identify the pavement components and compare highway and airport pavements.
2. Calculate the stresses and ESWL in flexible pavements.
3. Design the flexible pavement using empirical, semi empirical and IRC methods.
4. Analyze the warping, friction, wheel load stress and calculate the combined stress.
5. Design rigid pavements by IRC method.

## CEPE21 TRANSPORTATION PLANNING

### Course Learning Objectives

1. To know about the processes and concepts of transportation planning
2. To study about trip generation
3. To study about trip distribution
4. To study about modal split analysis
5. To study about trip assignment

### Course content

Transportation Planning Process and Concepts - Role of transportation - Transportation problems - Urban travel characteristics - Concept of travel demand - Demand function - demand estimation - Sequential, recursive and simultaneous processes

Trip Generation Analysis - Zoning - Types and sources of data – O-D studies - Expansion factors - Accuracy checks - Trip generation models - Zonal models - Household models - Category analysis - Trip attractions of work centers.

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

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

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

### References

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



## Course outcomes

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

1. Apply the principles of the transportation planning process and demand estimation.
2. Analyse the trip production and trip attraction models.
3. Analyse the growth factor, gravity and opportunity models.
4. Apply the mode choice behaviour and mode split models.
5. Apply the shortest path models for route assignment.

## CEPE22 AIR POLLUTION MANAGEMENT

### Course Learning Objectives

1. To provide general understanding of air quality and its impact on the environment
2. To understand the fundamentals of meteorology and stability of atmosphere
3. To study the fate and transport of air pollutants and its measurement techniques
4. To discuss the different control methods and its principles for gaseous pollutant
5. To review the sources and control of indoor air pollution

### Course Content

Air pollutants – Sources – Classification of air pollutants – Particulates and gaseous pollutants – Effects of air pollutants on human health, vegetation and property – Global issues and air pollution – Global warming – Ozone layer depletion – Ambient air quality and emission standards – Air pollution indices – Air act. Fundamentals of meteorology – Wind roses – Atmospheric stability – Atmospheric diffusion of pollutants – Transport, transformation and deposition of air contaminants – Plume behaviour – Atmospheric diffusion theories – Plume rise – Gaussian dispersion models. Control principles – Principles and equipment description of control technologies – Particulates control by Gravitation, centrifugal, filtration, scrubbing, electrostatic precipitation – Absorption, adsorption, condensation, incineration and biofiltration for control of gaseous air pollutants – Biological air pollution control technologies – Bioscrubbers, biofilters. Air pollutants in indoor environments – Levels of pollutants in indoor and outdoor air – Indoor air pollution from outdoor sources – Measurement methods – Control Technologies.

### References

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



6. Peavy H. S., Rowe D. R. and Tchobanoglous G., *Environmental Engineering*, McGraw Hill, New York, 1985.
7. Mahajan S. P., *Pollution Control in Process Industries*, Tata McGraw-Hill Publishing Company, New Delhi, 1991.

### **Course Outcomes**

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

1. identify the types and sources of air pollutants
2. predict the effects of air pollutants on human health and the environment
3. choose appropriate technologies for removal of particulates and gaseous pollutants
4. measure the pollutant concentration in indoor environment
5. suggest the control techniques for indoor air pollution

## **CEPE23 INDUSTRIAL WASTEWATER TREATMENT**

### **Course Learning Objectives**

1. To study characteristics of industrial wastewater and its effects on water bodies
2. To know the quality of industrial effluents required before disposal on environment
3. To learn various physico-chemical and biological treatment techniques to treat industrial wastewater
4. To gain knowledge about the reuse of treated industrial effluents
5. To give exposure on common effluent treatment plants

### **Course Content**

Industrial wastewater – Characteristics – Environmental impacts – Effects of industrial wastes on streams, land – Effluent standards – Scenario in India – Regulatory requirements for industrial wastewater – Prevention Vs control of industrial pollution – Volume reduction – Process Modification – Strength reduction – Methods and materials changes – Waste minimization strategies – Zero discharge concept. Physico-chemical treatment of industrial wastewater – Equalization and neutralization – Separation of solids – Removal of organic and inorganic solids – Oil separation – Precipitation – Membrane methods – Reverse Osmosis – Biological treatment methods – Aerobic and anaerobic methods. Separation Vs degradation methods – Chemical oxidation – Photocatalysis – Ozonation – Ion exchange – Advanced oxidation processes – Electrochemical methods – Nutrient removal – Land treatment – Sludge production and its management – Quantification and characteristics of sludge – Treatment of sludge and its disposal. Reuse of industrial wastewater – Advantages – Quality requirements for reuse – Zero effluent discharge systems – Residuals of industrial wastewater treatments – Individual and common effluent treatment plants.

### **References**

1. Eckenfelder, W. W., *Industrial Water Pollution Control*, McGraw Hill, 2014.
2. Nemerow N. L., *Industrial Water Pollution*, Addison-Wesley Publishing Company Inc., USA, 1978.
3. Narayana Rao M. and Amal K. Dutta, *Wastewater Treatment*, Oxford & IBH Publishing Co., Pvt., Ltd., New Delhi, 2001.



4. *Bhatia S. C., Handbook of Industrial Pollution and Control, Volume I & II, CBS Publishers, New Delhi, 2003*
5. *Mahajan, S. P., Pollution Control in Process Industries, Tata McGraw Hill Publishing Company, New Delhi, 1991.*

### **Course Outcomes**

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

1. recognize various environmental problems due to improper management of industrial wastewater
2. determine appropriate technologies for treatment and management of industrial pollutants
3. recommend different techniques for the safe disposal of industrial effluents
4. analyse the quality requirements for reuse of industrial effluents

### **CEPE24 ENVIRONMENTAL MANAGEMENT AND IMPACT ASSESSMENT**

#### **Course Learning Objectives**

1. To learn the importance of environmental impact assessment in various development projects
2. To understand the legal provisions on EIA and EIA notifications
3. To brief the various methodologies involved in environmental impact assessment
4. To identify the prediction tools for the assessment of different environmental impacts
5. To describe the concepts of environmental management system.

#### **Course Content**

Impacts of development projects on environment and Environmental Impact Assessment (EIA) and Environmental Impact Statement (EIS) – Objectives – EIA Types – EIA in project cycle – Capacity and limitations – Legal provisions on EIA – Environmental Impact Assessment notification – Environmental Impact Assessment consultants. Methods of categorization of industries for EIA – Elements of EIA – Process screening, baseline studies, mitigation, matrices, checklist – Methods of EIA – Strength, weakness and applicability – Appropriate methodology solution. Prediction and Assessment of Impact on land, water, air, noise and energy, flora and fauna - Socio economic impact – Mathematical models for impact prediction, rapid EIA, public participation – Post environmental audit. Plan for mitigation of adverse impact on environment – Options for mitigation of impact on water, air and land, energy, flora and fauna; addressing the issues related to the project affected people – Environment Management Plan – ISO 14000. EIA case studies for new and expansion projects – wastewater treatment plants, water supply and drainage, highways and bridges, railways, dams, irrigation projects, power plants.

#### **References**

1. *Canter, R. L., Environmental Impact Assessment, McGraw Hill Inc., New Delhi 1996.*
2. *Anjaneyulu, Y., Environmental Impact Assessment Methodologies, B. S. Publications, Hyderabad, 2002.*
3. *Shukla S. K. and P. R. Srivastava, Concepts in Environmental Impact Analysis, Common Wealth Publishers, New Delhi, 1992.*





4. *John G. Rao and David C. Hooten (Ed.), Environmental Impact Analysis Handbook, McGraw Hill Book Company, 1990.*

### **Course Outcomes**

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

1. analyse the environmental impacts of proposed projects
2. categorize the type of EIA required for proposed projects
3. predict and assess the impact of proposed projects on the environment
4. use mathematical tools to predict the environmental impacts
5. propose proper mitigation measures to avoid environmental impacts
6. summaries the EIA report with suitable environmental management plan

### **CEPE25 SOLID WASTE MANAGEMENT TECHNIQUES**

#### **Course Learning Objectives**

1. To understand the sources, types and composition of municipal solid waste and the factors governing their generation
2. To acquire an understanding on the reduction, segregation and storage of wastes at source
3. To familiarize the different waste collection systems and their analysis
4. To study the importance of transfer stations and processing technologies for resource recovery
5. To enumerate and describe different disposal and treatment methods for municipal solid waste

#### **Course Content**

Sources and types of municipal solid waste – Waste generation rates – Factors affecting generation, composition, characteristics - Methods of sampling – Effects of improper disposal of solid wastes – Public health and environmental effects. Elements of solid waste management – Municipal solid waste rules – Source reduction of waste – Reduction, Reuse and Recycling – Segregation of wastes at source – Onsite storage methods – Materials used for containers – Case studies under Indian conditions. Methods of collection of municipal solid wastes – Collection vehicles – Manpower – Collection routes – Analysis of collection systems – Need for transfer and transport – Transfer stations – Selection of location, operation & maintenance. Objectives of waste processing – Processing technologies – Biological and chemical conversion technologies – Resource recovery from solid waste – composting and biomethanation – Thermal processing options. Land disposal of solid waste – Sanitary landfills – Site selection, design and operation of sanitary landfills – Landfill liners – Management of leachate and landfill gas – Landfill closure and environmental monitoring – Landfill bioreactor – Dumpsite rehabilitation.

#### **References**

1. *George Tchobanoglous and Frank Kreith Handbook of Solid Waste Management, McGraw Hill, New York, 2002.*
2. *Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2000.*
3. *Peavy H. S., Rowe D. R. and Tchobanoglous G., Environmental Engineering, McGraw Hill, New York, 1985.*
4. *Davis M. L. and Cornwell D. A., Introduction to Environmental Engineering, Tata McGraw Hill Education Pvt. Ltd, New Delhi, 2010.*



5. *Bhide A. D. and Sundaresan, B. B. Solid Waste Management Collection, Processing and Disposal, 2001.*
6. *Manser A. G. R and Keeling A. A, Practical Handbook of Processing Recycling of Municipal Solid Wastes, Lewis Publishers, CRC Press, 1996.*

### **Course Outcomes**

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

1. explain the various functional elements involved in solid waste management system
2. quantify and categorize solid wastes for any region
3. analyse the collection route and collection system
4. select suitable waste processing technologies and disposal methods
5. design a suitable sanitary landfill for disposal of solid waste on land

### **CEPE26 MODELS FOR AIR AND WATER QUALITY**

#### **Course Learning Objectives**

1. To provide an understanding of mass balance approach for the prediction of air and water quality
2. To study the transport phenomena of contaminants in surface water
3. To develop mathematical model for transport of contaminants in river and estuaries
4. To brief the models for lakes, and microorganisms growth and decay
5. To give an idea of micro meteorological processes and its role in the transport of air pollutants

#### **Course Content**

Introduction to mathematical models – Modelling approaches to water quality – Classification of models. Conservation of mass – mass balance – steady state system – time variable response systems. Mathematical models for water quality – Mass transport mechanisms – Model development, calibration and verification – Model limitations. DO and BOD models for streams: Streams and sinks of dissolved oxygen – Streeter Phelps model – Oxygen sag curve – Determination of deoxygenation and reaeration coefficients – Benthic oxygen demand. Models for estuary and lakes: Water quality distribution in estuaries – Modelling estuaries and lakes for water quality – Temperature models for lakes. Models for microorganisms – Growth and Decay. Air quality models – Micrometeorological processes – wind rose and stability classes – Gaussian dispersion model – Line source models – Indoor air quality model.

#### **References**

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

#### **Course Outcome**

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

1. explain various transport mechanisms in estuary and river



2. develop mathematical model for water quality
3. predict the quality of water in river, lakes and estuaries using mass balance approach and specific models
4. determine the microbial population using various growth models
5. quantify the concentration of pollutant in ambient air using dispersion models

## **CEPE27 ADVANCED FOUNDATION ENGINEERING**

### **Course Learning Objectives**

1. To explain the analysis of sheet pile wall under different support conditions
2. To explain overall stability analysis of well foundation
3. To explain fundamentals of soil dynamics and its application to machine foundation analysis including Codal provisions
4. To explain problems related to expansive soils and solution to overcome
5. To explain the concept of slope stability analysis for various slope conditions including graphical methods

### **Course Content**

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

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

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

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

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

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

### **References**

1. Bowles, J.E., *Foundation Analysis and Design*, McGraw Hill., 1996.
2. Braja M. Das, *Principles of Foundation Engineering*, Thomas Asia Pvt. Ltd., Singapore, 2005.
3. Shamsher Prakash, *Soil Dynamics*, McGraw - Hill Book Company, 1985.

### **Course outcomes:**

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

1. analyze and design any kind of sheet pile wall system including coffer dam
2. analyze and design well foundation including complete stability analysis
3. estimate soil parameters under dynamic conditions including machine foundations



4. design a suitable foundation system for any kind of problematic soils
5. analyze the stability of any kind of slope by using both theoretical and graphical methods

## **CEPE28 GEOTECHNICAL EARTHQUAKE ENGINEERING**

### **Course Learning Objectives**

1. To explain the mechanism of earthquake and its related causes to build structures and in-situ soils
2. To explain how ground motion is recorded and how do quantify the earthquake intensity and frequency related parameters
3. To explain how seismic site investigation will be done and seismic soil design parameters are estimated
4. To explain how seismic resistant design of foundation will be done and also explain the concept of liquefaction and related causes including codal recommendations
5. To explain how to do hazard assessment and mitigation and explain how do prepare a risk and microzonation mapping

### **Course Content**

Mechanism of Earthquakes - Causes of earthquake - Earthquake Fault sources - Elastic Rebound theory - Seismic wave in Earthquake shaking - terminology - Locating an earthquake - Quantification of earthquakes. Strong Motion Records - characteristics of ground motion - Factors influencing Ground motion - Estimation of frequency content parameters

Seismic site investigations – Selected Case Studies - Evaluation of Dynamic soil properties – Codal Provisions

Design Ground Motion - Developing Design Ground Motion-Codal recommendations.

Earthquake Resistant Design of foundation of buildings - Design considerations -. Earthquake Response of slopes - Evaluation of slope stability - Liquefaction-Susceptibility - Liquefaction Resistance-Codal recommendations.

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

### **References**

1. *Kameswara Rao, N.S.V., Dynamics soil tests and applications, Wheeler Publishing - New Delhi, 2000.*
2. *Krammer S.L., Geotechnical Earthquake Engineering, Prentice Hall, International Series, Pearson Education (Singapore) Pvt. Ltd., 2004.*
3. *Kameswara Rao, Vibration Analysis and Foundation Dynamics, Wheeler*
4. *Robert W. Day, Geotechnical Earthquake Engineering Hand book, McGraw Hill, 2002*

### **Course outcomes**

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

1. demonstrate the principles of earthquake loading
2. quantify earthquake intensity and ground motion



3. estimate seismic soil design parameters
4. analyze and design seismic resistant foundation for buildings
5. prepare soil risk and microzonation maps

## **CEPE29 REINFORCED EARTH AND GEOTEXTILES**

### **Course Learning Objectives**

1. To explain the basic mechanisms of soil reinforcement and design principles in reinforced earth wall
2. To understand the applications of geosynthetics in geotechnical problems and its design principles
3. To explain the usage of geosynthetics in geoenvironmental and pavement engineering with design
4. To explain the present status of development in geo-synthetics and filed instrumentation and control

### **Course content**

Reinforced Earth – The mechanisms of the reinforced earth techniques – Design principles – Materials used for construction – Advantages of reinforced earth – Reinforced earth construction techniques.

An overview of Geosynthetics, Description of Geotextiles – Geogrids – Geonets – Geomembranes – Geocomposites– Geocells – Designing with Geotextiles – Geotextile properties and test methods – Functions of Geotextile – Design methods for separation – stabilization – filtration – Drainage.

Designing with Geogrids – Geogrid properties and test methods – Designing with Geonets – Geonet properties and test methods – Designing with Geomembranes – Geomembrane properties and test methods – construction practices with Geotextiles, Geogrids, Geonets, Geomembranes.

Design of liquid Contaminant liners – liquid contaminant liners – Covers for reservoirs- Water conveyance (Canal liners)-- solid material liners – underground storage tanks – Design of pavements – Geo composites as liquid /Vapour Barriers – Improvement in bearing capacity – Erosion Control for water ways.

Geo Synthetics: Recent research and Developments. Control of Improvement – Field Instrumentation – design and analysis for bearing capacity and settlement of improved deposits.

### **References**

1. *Robert M. Koerner, Designing with Geosynthetics, Prentice Hall, 1989 .*
2. *Rao, G. V., and Suryanarayana Raju, G. V. S., Engineering with Geosynthetics, Tata Mc Graw Hill Publishing Co. New Delhi, 1990.*
3. *Shukla, S. K., Geosynthetics and their Applications, Thomas Telford, London,2002.*

### **Course outcomes**

Upon completion of this course, the students will be able to

1. Understand the principles of soil reinforcement and they can able to do any reinforced wall design using steel strip or geo-reinforcement



2. Understand the application of geosynthetics in geotechnical engineering
3. Decided what kind of geosynthetics should be used for the problem specific application including its design principles
4. Do proper field test using the recent development in geosynthetics

### **CEPE30 EARTH AND EARTH RETAINING STRUCTURES**

#### **Course Learning Objectives**

1. To explain the concept of earth dam design including stability analysis under seepage
2. To evaluate stability of slopes under different drainage conditions using different methods including slope protection and quality control
3. To estimate active and passive earth pressure using different earth pressure theory including graphical method
4. To explain design principles of retaining structures and coffer dams

#### **Course content**

Introduction: Earth dams – types of dams – selection of type of dam based on material availability – foundation conditions and topography- Design details – crest, free board, upstream and downstream slopes, upstream and downstream slope protection – central and inclined cores – types and design of filters- Seepage analysis and control – seepage through dam and foundations – control of seepage in earth dam and foundation.

Stability analysis – critical stability conditions – evaluation of stability by Bishop's and sliding wedge methods under critical conditions - Construction techniques – methods of construction –quality control Instrumentation – measurement of pore pressures.

Rigid retaining structures – active and passive earth pressures against gravity retaining walls – Surcharge - computation of earth pressures by Trial wedge method – a mathematical approach for completely submerged and partly submerged backfills – importance of capillarity tension in earth pressure.

Graphical methods of earth pressure computation – trial wedge method for coulomb's and Rankine's conditions, for regular and irregular ground and wall conditions – Rebhan's construction for active pressure – friction circle method – logarithmic spiral method.

Design of gravity retaining wall – cantilever retaining walls - Flexible retaining structure – type and methods of construction – design strength parameters – safety factor for sheet pile walls – computation of earth pressures against cantilever sheet piles in cohesionless and cohesive soils – anchored sheet piles – free earth method – fixed earth method – Rowe's moment reduction method – stability of sheet piling Diaphragm walls and coffer dams – type of diaphragm walls and their construction techniques in various soil types –earth pressure on braced cuts and coffer dams – design of coffer dams

#### **References**

1. Clayton, Milititsky and Woods, *Earth Pressure and Earth-Retaining Structures*, Taylor and Francis, 1996
2. Huntington, *Earth pressure on retaining walls*, John Wiley and Sons, 1957.



3. *Bowles, Foundation Analysis and Design, 1968.*
4. *Jones, Earth Reinforcements and Soil structures, 1996.*
5. *Prakash, Ranjan and Saran, Analysis and Design of Foundations and Retaining structures, Saritha Prakashan, Meerut, 1977.*

### **Course outcomes**

Upon completion of this course, the students will be able to

1. Do earth dam design and stability analysis for all kind of drainage conditions
2. Do stability analysis of any kind of slope and its protection
3. Understand the earth pressure theories and able to calculate lateral earth pressure for different conditions
4. Do retaining structure design and its stability analysis

## **CEPE31 MARINE FOUNDATION ENGINEERING**

### **Course Learning Objectives**

1. To emphasize the importance of offshore soil investigations for offshore structures
2. To analysis the response of foundations of gravity structures under offshore environmental loading
3. To analysis the foundation response of jacket and jack-up platforms under static and dynamic loading
4. To provide a suitable foundation system for mooring structures and offshore pipe lines

### **Course content**

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

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

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

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



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

### References

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

### Course outcomes

Upon completion of this course, the students will be able to

1. Recommend suitable offshore investigation techniques for the proposed project and able to provide appropriate soil design parameters
2. Perform foundation analysis for gravity structures, jacket and jack-up kind of offshore structures
3. Analysis suitable anchor system for mooring structures and able to provide foundation system for offshore pipeline.

## CEPE32 GEODETIC SURVEYING

### Course Learning Objectives

1. To know the significance of geodetic surveying in field measurements in terms of utility and precision of data collection
2. To learn the principles of Triangulation, Trigonometric levelling and their procedures
3. To get introduced to the concept of curves and curve setting
4. To know in detail different types of errors and their adjustments
5. To get introduced to the coordinate systems, reference plans and projections

### Course content

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

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

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





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

Reference Surfaces – Datums – Geoids – Coordinate systems – Map Projections

### References

1. *Duggal, S.K. Surveying Vol. I and II, Tata McGraw Hill, 2004.*
2. *Punmia, B.C. Surveying Vol. I and II, Standard Publishers, 1994.*
3. *Arora, K. R. Surveying Vol. I and II, Standard Book House, 1996.*
4. *Satheesh Gopi. Advanced Surveying, Pearson Education, 2007.*
5. *Satheesh Gopi. The Global Positioning System and Surveying using GPS, Tata McGraw, 2005.*

### Course Outcomes

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

1. Apply geodetic methods such as Triangulation in different fields of Civil Engineering
2. Apply geodetic methods such as Trigonometric levelling in different fields of civil engineering
3. Select the correct, best suited curve and set the curve on the road
4. Identify the errors present in the field observation and to adjust the errors using suitable methods
5. Demonstrate the principles of the earth surface, its projections and different coordinates involved in map making

## CEPE33 ADVANCED SURVEYING TECHNIQUES

### Course Learning Objectives

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

### Course content

Electro magnetic distance measurement (EDM) – Principle of EDM Carrier waves – Types of EDM instruments – Distomat – Total Station – Principle – procedure & surveying using Total Station – precise levelling - micro-optic theodolite.



Photogrammetry – Terrestrial and Aerial Photogrammetry – Horizontal position of a point from photographic measurement – elevation of a point – Determination of focal length of camera – determination of scale – Ground co-ordinates - Relief displacement – Photo interpretation.

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

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

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

### References

1. Duggal, S.K. *Surveying Vol. II*, Tata McGraw Hill, 2004.
2. Punmia, B.C. *Surveying Vol.III*, Standard Publishers, 2005.
3. Arora, K. R. *Surveying Vol. III*, Standard Book House, 1996.
4. Satheesh Gopi. *Advanced Surveying*, Pearson Education, 2007.
5. Satheesh Gopi. *The Global Positioning System and Surveying using GPS*, Tata McGraw, 2005.

### Course Outcomes

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

1. Apply advanced surveying techniques in different fields of Civil Engineering
2. Select the advanced technique which is best suited for a work
3. Apply total station and EDM in distance measurement and traversing
4. Demonstrate the principles of the earth surface, its projections and different coordinates involved in map making
5. Apply GPS in transportation engineering, structural engineering and land use planning

## CEPE34 GROUNDWATER HYDROLOGY

### Course Learning Objectives

1. To know different types of aquifers
2. To understand the surface and subsurface investigation in detail
3. To integrate the fundamental and basic knowledge of ground water movement
4. To understand the process of sea water intrusion and recharge
5. To introduce the different model studies

### Course content

Groundwater occurrence – distribution – aquifer – types - Surface investigation - Geophysical - electrical resistivity - Seismic refraction - Gravity and magnetic - Geologic - Air photo interpretation - Dowsing.



Subsurface investigation - test drilling - resistivity logging- potential logging - temperature and caliper logging.

Steady unidirectional flow - well in a uniform flow - steady flow with uniform recharge - unsteady radial flow to a well - well flow near aquifer boundaries - Multiple well systems - partially penetrating wells - characteristic well losses.

Secular and seasonal variations - Fluctuations due to evapo-transpiration, Meteorological phenomena, tides, external loads and earthquakes - control by drains and wells. Recharge through sewage pits, shafts and wells.

Occurrence of sea water intrusion - Ghypon-Heizberg relation between fresh and saline waters - shape length and structure of the fresh salt water interface - prevention and control of seawater intrusion - role of sea water in ground water - coastal zoning.

Sand models - Electrical models - Viscous fluid models - membrane models - numerical analysis methods

### References

1. *Raghunath H.M., Ground Water Hydrology, New-Age International, 2<sup>nd</sup> Edition, 1990.*
2. *Todd, D.K, Ground Water Hydrology, Prentice hall, 2004*

### Course outcomes

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

1. Identify types of aquifers
2. carry out surface and subsurface investigation to locate groundwater
3. visualise the occurrence and movement of groundwater
4. select suitable type of ground water recharge
5. Assess sea water intrusion and its control

## CEPE35 APPLIED HYDRAULICS ENGINEERING

### Course Learning Objectives

1. To classify the types of flows in open channel and also to design open channel sections in a most economical manner.
2. To study about non uniform flows in open channel and longitudinal slopes in open channel and also to learn about the characteristics of hydraulic jump.
3. To develop an understanding of fluid flow patterns and learn to use boundary layer theory and Drag.
4. To provide insights to the Open channel hydraulics and introduce dimensional analysis for fluid flow problems.

### Course content

Open channel flow and its classifications, and properties, energy and momentum principles, Critical flow computation and its applications, transitions with sub critical and super critical flows. Types and regimes of flow – Velocity distribution in open channel – Wide open channel



Design of non- erodible channels for uniform flow, most efficient channel section, compound Sections. Velocity measurement – Manning’s and Chezy’s formula – Determination of roughness coefficients – Determination of normal depth and velocity.

Gradually varied flow: Theory and analysis, gradually-varied flow computations in prismatic channels, gradually varied flow in non-prismatic channels. Characteristics of flow profiles

Draw down and back water curves – Profile determination – Graphical integration, direct step and standard step method – Flow through transitions

Rapidly varied flow- Theory of hydraulic jump, evaluation of jump elements in rectangular and non-rectangular channel, location of jump on horizontal floor, channel controls and transition – surges

Boundary Layer Theory: Introduction, Development of boundary layer over a flat plate, boundary layer thickness, displacement, momentum and energy thicknesses, Application of momentum equation to boundary layer flow, local and mean drag coefficients.

### References

1. Streeter, V.L. Fluid Mechanics, Tata McGraw Hill, 1998.
2. Chow, V.T. Open Channel Hydraulics, Tata McGraw Hill, 1975.
3. Nagaratnam, S. Fluid Mechanics, Khanna Publishers, 1989.
4. Chaudhry, M and Hanif. Open Channel Flow. Englewood Cliffs, NJ: Prentice-Hall, 1993.
5. Chanson, H (2004b).The Hydraulics of Open Channel Flow-An Introduction, (Butterworth-Heinemann, Oxford, UK) 2ndEdition (ISBN 07506 59785).

### Course outcomes

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

1. Acquire specific knowledge regarding fluid flow phenomena observed in Civil Engineering systems such as flow in open channel flow
2. Develop understanding of the basic principles of fluid flow patterns and boundary layer theory and provide skills in analyzing fluid flows in open channel hydraulics
3. Understand gradually varied flow profile in detail.
4. Understand rapidly varied flow profile in detail
5. Knowledge is useful for the design of open channels for rectangular and non-rectangular channels for hydraulic jump phenomena.

## **CEPE37 SIMULATION MODELLING FOR WATER RESOURCES ENGINEERING**

### Course Learning Objectives

1. To build on the student’s background in basics of simulation modelling.
2. To develop the skills in modelling of linear and nonlinear regression.
3. To develop skills in the artificial intelligence tools such as fuzzy systems, neural networks and genetic programming.
4. To provide wide knowledge on optimization tools.



## Course content

Introduction – Concepts of systems and systems Analysis; Systems Techniques in Water Resources: Optimization with methods using calculus.

Regression – linear regression - multiple regression – non linear regression – types – modelling concepts – Probabilistic functions in hydrology- Monte Carlo simulation - Linear Programming- simplex method – dual simplex method - graphical method.

Dynamic programming – forward recursion – backward recursion – water allocation problem – shortest path algorithm – water distribution network – stochastic dynamic programming.

Artificial Intelligence – Neural networks – concepts – back propagation – bias, neuron, weights - radial basis function – case studies – Genetic algorithm – ANN-basics.

Optimization tool- roulette wheel selection – mutation – crossover- case studies Reservoir optimization – Fuzzy inference system – Fuzzy linear programming.

## References

1. *Water Resources systems, Vedula and Majumdar, Tata Mcgraw hill Publishers.*
2. *Engelen, G.B., Kloosterman, F.H. Hydrological Systems Analysis, Water Science and Technology Library, Vol. 20.*
3. *Hydrologic Analysis and Design, Richard H. McCuen, Prentice-Hall, 1989. 3rdEdt*
4. *Engineering Hydrology: Principles and Practices, Ponce, Victor Miguel, Prentice-Hall, Inc., 1989.*

## Course outcomes

By the end of this course the students are able to

1. Incorporate skills in developing models for various systems.
2. Acquires knowledge on fundamentals of regression techniques.
3. Develops and improves the knowledge dynamic programming and stochastic programming.
4. Provides basic knowledge on fuzzy system and optimization tools.

## CEPE38 DESIGN OF OFFSHORE AND COASTAL STRUCTURES

### Course Learning Objectives

1. To understand different types of offshore structures
2. To study the different types of operational loads and environmental loads
3. To understand the different types of waves and wave deformation
4. To learn about breakwaters and coastal features

### Course Content

Types of offshore structures and conceptual development - Analytical models for jacket structures - Materials and their behaviour under static and dynamic loads - Statutory regulations - Allowable stresses - Various design methods and Code



Provisions - Design specification of API, DNV, Lloyd's and other classification societies - Construction of jacket and gravity platforms

Operational loads - Environmental loads due to wind, wave, current and buoyancy - Morison's Equation - Maximum wave force on offshore structure - Concept of Return waves - Principles of Static and dynamic analyses of fixed platforms - Use of approximate methods - Design of structural elements.

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

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

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

### References

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

### Course Outcome

By the end of this the students will be able to

1. Gain knowledge on different types of offshore structures
2. Understand the different types of loads acting on offshore structures
3. Gain understanding on waves in shallow water, diffraction, reflection and diffraction
4. Design breakwaters and other coastal defense structures
5. Understand the concepts of littoral drift, wave forces and coastal erosion protection

## CEPE39 COASTAL ENGINEERING

### Course Learning Objectives

1. To provide basic knowledge on two dimensional wave equation
2. To describe the various types of wave theories.



3. To study the effect of wave loads on different coastal structures
4. To improve the knowledge on physical modelling tools in offshore and onshore activities.

### **Course content**

Basic Fluid Mechanics: Conservation of mass and momentum, Euler Equation, Bernoulli's equation, potential flow, stream function. Waves: Classification of water waves - Two dimensional wave equation and wave characteristics.

Indian Scenario – Classification of Harbours. Introduction - wind and waves – Sea and Swell -Introduction to small amplitude wave theory – use of wave tables- Mechanics of water waves – Linear (Airy) wave theory, Introduction to Tsunami

Wave theories - Small amplitude waves – Finite amplitude waves - Stoke, Solitary and Cnoidal Water particle kinematics - wave refraction; wave breaking; wave diffraction random and 3D waves- Short term wave analysis – wave spectra and its utilities - Long term wave analysis- Statistics analysis of grouped wave data – Currents: Classification - Behaviour - Design Criteria, Scour and other effects of currents

Dynamic beach profile; cross-shore transport; along shore transport (Littoral transport), sediment movement – Estuaries – Creek – Harbour – Littoral drift.

Field measurement; models, groins, sea walls, offshore breakwaters, artificial beach nourishment - planning of coast protection works - Design of shore defense structures –Case studies.

### **References**

1. *Subratakumar Chakrabarti, Hand book of offshore engineering.*
2. *Coastal, Estuaries and Harbour Engineer's reference book, Michael Abbott, W Alan price.*
3. *Coastal Engineering Research reports.*

### **Course outcomes**

By the end of this course the students will be able to

1. Develop knowledge in basics of wave hydrodynamics
2. Provides understanding various aspects of coastal engineering
3. Describes wave forces, wave pressures and currents in the coastal areas.
4. Improves knowledge on sea defence structures.

## **CEPE40 DISASTER MODELLING AND MANAGEMENT**

### **Course Learning Objectives**

1. To know the types of Disasters and its triggering factors.
2. Understand the stages of disaster in hydrological disaster and kinds of data are required to support emergency management work during the disasters.
3. Develop and understand the causes, effects, impacts and analysis of hydrological, geological and coastal hazards.



4. Assess the potential of new, evolving technologies to meet vulnerability mapping, modelling and emergency management needs for geological hazards, hydrological and coastal hazards.

### **Course content**

Disasters: Definition- Hazard Risk, Mitigation, Natural and human induced disasters- types of hazards, disasters and catastrophes – Disaster Management.

Hydrological Hazards: Flooding – PMP – PMF – Inundation mapping -flood prone area analysis and management. Dam breach analysis - Drought- types of drought - Factors influencing drought - delimiting drought prone areas - drought index, SPI and Palmer.

Geological Hazards: Earthquakes; location, faults, causes, types, associated hazards and impacts, Richter scale and Modified Mercalli scale. Mass movements: Definition of landslide - types – causes - slope stability analysis.

Coastal Hazards – storm surge - Tsunami and floods – cyclone – coastal vulnerability – shore line erosion – shore defence structures.

Mitigation and Management: Hazard, Risk and Vulnerability mapping and modelling using GIS. Case studies for earth quake zonation. Risk Assessment - Preparedness- GIS case studies for earthquake, landslide–risk assessment–GIS case studies for earthquake, landslide and cyclones. Emergency Management Systems (EMS) in the Disaster Management Cycle.

### **Course outcomes**

By the end of this course the students will be able to

1. Understand different types of disaster and its triggering features
2. Understand and analyse hydrological disaster
3. Understand and develop models for geological disaster
4. Able to understand the coastal hazard and shore defence structures
5. Capable to preparing vulnerability mapping and risk assessment and developing Emergency Management System.

## **CEPE41 PREFABRICATED STRUCTURES**

### **Course learning Objectives**

The objective of the course is to

1. Understand the concepts and behaviour of prefabrication and types and its systems.
2. perform analysis and design of cross section and the joints in structures
3. to analyze and design of prefabricated concrete members
4. Obtain knowledge in design of cross section and the joints.

### **Contents**

Need for prefabrication – Types of prefabrication- Principles - Materials - Modular co-ordination – Standardization – Systems Production – Transportation – Prefabrication of load carrying members – Disuniting of structures – Design of cross section of load carrying members- handling and erection stresses Application of prestressing of roof members- floor systems- Wall panels- hipped plate and shell structures- Large panel constructions – Columns – Shear walls. Joints for different structural connections- Beam to Column, Beam to Beam, Column





to Column, Column to Foundation, Connections between wall panels, Connections between floor panels - Design of expansion joints- Jointing Materials. Production, Transportation and erection- shuttering and mould design – Dimensional tolerances- Design and detailing of prefabricated units

### References

1. Hass, A.M., Precast Concrete Design and Applications, Applied Science Publishers, 1991
2. Promyslowl, V., Design and Erection of Reinforced Concrete Structures, MIR Publishers Moscow, 1980
3. Gerostiza C.Z., Hendrikson C. and Rehat D.R., Knowledge Based Process Planning 76 for Construction and Manufacturing, Academic Press Inc., 1980
4. Bauverlag, GMBH, 1971. 3. Structural Design Manual, Precast Concrete Connection Details, Society for the Studies in the Use of Precast Concrete, Netherland Betor Verlag, 1978.
5. Levitt M., “Precast Concrete Material, Manufacture, Properties and Usage” Applied Science Publishers Ltd., 1982.
6. Bruggeling A.S.G. and G.F.Huyghe, Prefabrication with concrete, Netherlands: A.A. Balkema Publishers, 1991.

### Course outcomes

On completion of this course students should be able to:

1. Know the behaviour of prefabricated structures
2. Become familiar with the production of prefabrication units and erection process.
3. Able to perform an industry relevant design project in a team setting
4. Exhibit their knowledge in designing and detailing of prefabrication units

### **OPEN ELECTIVE (OE)**

#### **CEOE10 REMOTE SENSING AND GIS**

### Course Learning Objectives

1. To know about the principles of remote sensing and spectral signatures
2. To know about satellites, types of remote sensing and digital image processing
3. To study about the history and components of GIS
4. To study about data types and operations.
5. To know the applications of remote sensing and GIS for various fields of Civil Engineering,

### Course content

Remote Sensing – Principle - Electro-magnetic energy, spectrum - EMR interaction with atmosphere – Atmospheric Windows and its Significance – EMR interaction with Earth Surface Materials – Spectral Signature and Spectral Signature curves for water, soil and Earth Surface.

Satellites - Classification – Satellite Sensors – satellite and sensor parameters - Resolution – Types of Remote Sensing - Visual Interpretation of Satellite Images – Digital Image processing – Characteristics of different platforms: Landsat, SPOT,



IRS series, IKONOS, QUICKBIRD – Radar, LIDAR, SAR, MODIS, AMSRE, Sonar remote sensing systems introduction of GPS- data receiving mode- DTM generation- View shed analysis.

GIS - History of Development - Components of GIS – Hardware, Software and Organizational Context – Data – Spatial and Non-Spatial – Data Input Sources— DBMS – Data Output - Data models - Raster and Vector data structures – Data compression – Raster vs. vector comparison.

Analysis using Raster and Vector data – Operations – Overlaying - Buffering – Modelling in GIS - Digital Terrain Modelling, Analysis and application – Products of DEMs and their uses – Sources of errors in GIS and their elimination.

Applications of Remote Sensing and GIS – Advanced applications of GIS – Disaster management, Water resource, Landuse – Land cover – Urban planning - Intelligent Transport Systems - Development of Resources Information Systems.

### **References**

1. *Burrough P.A. and Rachel A. McDonell, Principles of Geographical Information Systems, Oxford Publication, 2004.*
2. *C.P. Lo and Albert K. W. Yeung, Concepts and Techniques of Geographical Information Systems, Prentice- Hall India, 2006.*
3. *Thomas. M. Lillesand and Ralph. W. Kiefer, Remote Sensing and Image Interpretation, John Wiley and Sons, 2003.*

### **Course outcomes**

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

1. Demonstrate the concepts of Electro Magnetic energy, spectrum and spectral signature curves.
2. Apply the concepts of satellite and sensor parameters and characteristics of different platforms.
3. Apply the concepts of DBMS in GIS.
4. Analyze raster and vector data and modeling in GIS.
5. Apply GIS in land use, disaster management, ITS and resource information system.

## **CEOE11 OCEAN ENERGY**

### **Course Learning Objectives**

1. Learn the basics of ocean environment
2. Understand the concept of wave measurement and linear wave theory
3. Learn the ocean tidal current turbulence and wave energy systems
4. Develop model testing techniques for marine current turbines

### **Course Content**

Introduction to the ocean environment - Ocean circulation and stratification - Ocean habitat - Ocean economy - Ocean surface waves - Wave measurement - Linear wave theory - Wave spectrum - Wave energy resource



Ocean tidal currents - Current measurement - Current turbulence o Current energy resource - Site selection and characterization for ocean energy system - Wave energy systems - Types of wave energy converters - Linear wave-structure interactions - Frequency domain analysis - Hydrodynamic coefficients and their computation - Time domain analysis - Phase control Arrays

Model testing techniques - Marine current turbines - Types of marine current turbines Hydrodynamic models (BEM, Lifting line, IBEM) - Hydrofoil data and analysis

Cavitation and strength - Design criteria - Multiple turbine interaction - Other types of energy systems o- Ocean Thermal Energy Conversion (OTEC) - Energy from salinity gradient

Power take-off systems - Air turbines, Water turbines - High pressure hydraulic systems - Electrical generation - Energy storage - Mooring and anchoring systems. Operation and maintenance of ocean energy devices - Offshore operations - Maritime safety issues

### References

1. *Sorensen, Bent, Renewable Energy, Its Physics, Engineering , environmental impacts, economics, and planning, 3<sup>rd</sup> Ed. Elisver Academic Press, London, 2004*
2. *Twidell, John and Weir, Tony, Renewable Energy Resources, Taylor and Francis, 2005*

### Course Outcomes

By the end of this course the students will be able to

1. Understand the basics of ocean energy sources
2. Capable of understanding the concepts of measurements of current and tides by using measuring devices
3. Understand the different types of marine turbines
4. Improves knowledge on water turbines, Electrical operations and marine safety
5. Understand OTEC

## CEOE12 EARTHQUAKE ENGINEERING

### Course Learning Objectives

1. To introduce the basics of Earthquake Engineering
2. To understand the mechanism of earthquake wave propagation
3. To explain about seismic measuring devices and scales
4. To explain how to do hazard assessment and mitigation and explain how do prepare a risk and microzonation mapping
5. To explain about various seismic protection methods

### Course content

Importance of earthquake engineering – Earth structure – Plate tectonics - Faults – Earthquake generation mechanism – terminologies

Earthquake propagation - Seismic waves in Earthquake shaking – body waves and surface waves – attenuation of wave amplitudes



Measurement of earthquakes – Intensity scales – Seismographs and Seismograms – Magnitude scales – seismic moment and moment magnitude – Accelerographs and Accelerograms

Seismic hazard assessment – methods – ground motion intensity at given site and in given time interval – probabilistic and semi-probabilistic approaches – seismic zonation and microzonation maps

Seismic protection methods – base isolation – energy dissipating devices - Codal provisions

### References

1. Villaverde R. (2009). Fundamental Concepts of Earthquake Engineering, 1st Edition, CRC Press
2. Elnashai S. and L. Di Sarno (2008). Fundamentals of Earthquake Engineering, 1st Edition, John Wiley and Sons
3. Krammer S.L., Geotechnical Earthquake Engineering, Prentice Hall, International Series, Pearson Education (Singapore) Pvt. Ltd., 2004.

### Course outcomes

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

1. apply the basics of Earthquake Engineering
2. understand the earthquake wave generation and its propagation mechanism
3. knowledge on earthquake measuring scales and instruments
4. quantify earthquake intensity and ground motion
5. identify the method to protect the structure from seismic forces

## CEOE13 URBAN AND REGIONAL PLANNING

### Course Learning Objectives

1. To develop an awareness about the trends in urbanization
2. To understand the basic principles and concepts of urban planning
3. To learn the laws and regulations related to the planning process existing in the country.
4. To be acquainted with the various stages of the planning process
5. To get introduces to the various agencies and organizations involved in the planning process

### Course Content

Definition and classification of urban areas - Trend of urbanization - Planning process - Various stages of the planning process - Surveys in planning.

Plans - Delineation of planning areas -Regional plan, Master plan, Structure plan, detailed development plan and Transportation plan.

Planning principles of Ebenezer Howard (Garden city movement), Patrick Geddes, Dr. C. A. Doxiades, Soria Y Mata (Linear city) and Clarence, A. Perry (The neighbourhood concept).

Plan implementation - Urban Planning agencies and their functions – Financing - Public, private, Non-governmental organizations - Public participation in Planning.



Development control regulations - Town and country planning act - Building bye-laws.

### References

1. Hutchinson, B.G., Principles of Urban Transport Systems Planning, Scripta, McGraw-Hill, New York, 1974.
2. Claire, Hand Book of Urban Planning, Van Nostrand Book Company, 1974.
3. Gallian, B. Arthur and Simon Eisner, The Urban Pattern - City Planning and Design, Affiliated Press Pvt. Ltd., New Delhi, 1985.
4. Margaret Roberts, An Introduction to Town Planning Techniques, Hutchinson, London, 1980.
5. Hiraskar, G. K., Fundamentals of Town Planning, Dhanpat Rai Publications, 1992.

### Course Outcomes

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

1. Demonstrate the various process involved in urban planning
2. Apply the laws and governmental policies related to the planning process
3. Implement the classical urban planning principles
4. Apply the methods of financing of plans
5. Demonstrate the regulations and by-laws

### CEOE14 EXPERIMENTAL STRESS ANALYSIS

#### Course Learning Objectives

1. To study the working principles of different types of strain gauges
2. To understand the model analysis
3. To know the fundamentals of photo elastic coatings
4. To study the effects of 2-D photo elasticity
5. To study the working principle of load, pressure and displacement transducers

#### Course Content

Strain gauges – Mechanical, optical, acoustic, electrical inductance and capacitance pneumatic types – description and working principles

Electrical resistance strain gauges, gauge characteristics and types – Equipment for recording static strain – reduction of strain gauge data. Load, pressure and displacement transducers.

Model analysis – direct and indirect models – law of structural similitude – choice of scales – Model materials – limitations of model studies –Buckingham PI theorem – design of direct and indirect models – Beggs deformeter and its applications.

Two dimensional photo – elasticity – optical principles stress optic law – Methods of producing isoclines and isochromatics using polariscopes – Methods of measuring fractional fringe orders – model materials – separation techniques

Fundamental of Photo elastic coatings, Moire fringe and brittle coating techniques – Introduction to stress freezing techniques – Introduction to non-destructive testings



## References

1. Daley and Riley, *Experimental Stress Analysis*, McGraw Hill Book Company, 1987
2. Srinath, L.S. et al., *Experimental Stress Analysis*, Tata McGraw Hill 1984.
3. Hetenyi, M., *Hand Book of Experimental Stress Analysis*, John Wiley & Sons. Inc New York. 1980.

## Course outcomes

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

1. identify the different types of strain gauges
2. carry out model analysis
3. apply the concepts of photo elastic coatings
4. analyze the behavior of 2-D photo elasticity
5. apply the working principles of transducers

## CEOE15 HEALTH MONITORING OF STRUCTURES

### Course Learning Objectives

To investigate the materials, products, structures or components that fall or do not operate or function as intended causing personal injury or damage the property.

### Course content

Introduction- Qualitative and non-continuous methods of evaluation of structures- SHM definition- Detecting the existence of the damage on the structure- Locating the damage- Identifying the types of damage- Quantifying the severity of the damage- Sensors- Feature extraction through signal processing and statistical classification- Structure- Data acquisition systems-Data transfer and storage mechanism-Data management- Data interpretation and diagnosis : System Identification-Structural model update-Structural condition assessment-Prediction of remaining service life

Different sensors - accelerometers, strain gauges, displacement transducers, level sensing stations, anemometers, temperature sensors and dynamic weight-in-motion sensors- Case studies- SHM for bridges

### References

1. Raghavan, A. and Cesnik, C. E., *Review of guided-wave structural health monitoring*, " Shock and Vibration Digest, vol. 39, no. 2, pp. 91-114, 2007.
2. Shen-En Chen, R. Janardhanam, C. Natarajan, Ryan Schmidt, *Ino-U.S. Forensic Practices - Investigation Techniques and Technology*, ASCE, U.S.A., 2010.
3. Natarajan C., R. Janardhanam, Shen-En Chen, Ryan Schmidt, *Ino-U.S. Forensic Practices - Investigation Techniques and Technology*, NIT, Tiruchirappalli, 2010.
4. Gary L. Lewis, *Guidelines for Forensic Engineering Practice*, ASCE, U.S.A., 2003.
5. Joshua B.Kardon, *Guidelines for Forensic Engineering Practice*, ASCE, U.S.A., 2012.



## Course outcomes

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

1. Perform Structural health monitoring
2. Handle emerging technologies using sensors
3. Perform notable applications of structural health monitoring in Civil applications

## CEOE16 FORENSIC ENGINEERING

### Course Learning Objectives

1. To undertake problem diagnostics and treatment during the structural design and construction phase.
2. To identify, diagnose and treat complex problems in relation to whole-of-life reliability and resilient performance during occupancy.

### Course content

Introduction- competencies and qualification of Forensic Engineers-Failure of Structures- performance problems – responsibility and accountability — learning from failures – causes of distress in structural members – Diagnosis and Assessment of Distress: Visual inspection – non- destructive tests- Rebound hammer method- Ultrasonic Pulse Velocity method – crack detection techniques – case studies – single and multistorey buildings. Environmental Problems and Natural Hazards: Effect of corrosive, chemical and marine environment – pollution and carbonation problems – durability of RCC structures – damage due to earthquakes and flood- strengthening of buildings – provisions of BIS 1893 and 4326. Modern Techniques of Retrofitting: Structural first aid after a disaster – guniting - jacketing –Concrete chemicals– application of polymers – Ferro cement and fiber concretes as rehabilitation materials – mortar repair for cracks- shoring and underpinning - Case studies

### References

1. Raikar, R.N., *Learning from failures – Deficiencies in Design, Construction and Service R&D Centre (SDCPL), Raikar Bhavan, 1987.*
2. Dovkaminetzky, *Design and Construction Failures, Galgotia Publication, NewDelhi, 2001.*
3. Shen-En Chen, R. Janardhanam, C. Natarajan, Ryan Schmidt, *Ino-U.S. Forensic Practices - Investigation Techniques and Technology, ASCE, U.S.A., 2010.*
4. Natarajan C., R. Janardhanam, Shen-En Chen, Ryan Schmidt, *Ino-U.S. Forensic Practices - Investigation Techniques and Technology, NIT, Tiruchirappalli, 2010.*
5. Gary L. Lewis, *Guidelines for Forensic Engineering Practice, ASCE, U.S.A., 2003.*
6. Joshua B.Kardon, *Guidelines for Forensic Engineering Practice, ASCE, U.S.A., 2012.*



### **Course outcomes**

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

1. Describe and evaluate the use of structural forensics in creating and maintaining of Civil infrastructure
2. Identify the common failure modes
3. Investigate the structural failures, reverse engineer the lessons learnt and produce technical notes.

### **MINOR (MI)**

### **CEMI10 CONSTRUCTION TECHNOLOGY**

#### **Course Learning Objectives**

1. To know the properties and applications of different construction materials
2. To understand the production, processing and testing of concrete
3. To learn the construction principles, formwork and other construction methods
4. To study the types of building finishes and building services
5. To learn the different repair techniques in construction

#### **Course content**

Building materials: Classification and requirements of good stone and brick, Brick manufacturing, Harmful ingredients, testing, Constituent of a good brick earth, Lime, manufacturing, Field-testing, Artificial hydraulic lime; Timber: classification, structure, seasoning, defects; Paints: Constituents, types, characteristics of varnishes.

Concrete technology: High grade cements, Advances in manufacture of cement, Concrete Mix Design; Process of manufacture of concrete, Batching, mixing, transporting, placing, compaction, curing, finishing; Testing of fresh and hardened concrete; Non-destructive testing.

Principles of building construction: Bonding, Reinforced brick work, Stone masonry, Hollow block masonry, Composite masonry, Cavity walls, Flooring, Formwork, Shoring and Scaffolding, Slip and moving forms, Roofs and roof coverings, Under pinning, Submerge structures.

Building items: Plastering & pointing, Painting, Distempering and white washing; Damp proof course (DPC), Anti-termite measures and treatments; Construction joints; Plumbing and electrification, various types of fittings and laying procedure.

Construction damages & repair techniques: Causes of damage and deterioration in masonry and concrete structures, Symptoms & Diagnosis, Types of repair and rehabilitation techniques; Case studies.

#### **References**

1. Duggal, S.K., Building Materials, New Age International, 2009.
2. Rangwala, S.C., Engineering Materials, Charotar, 2015.
3. Arora, S.P. and Bindra, S.P., Building Construction, Dhanpat Rai and Sons, 1997
4. Punmia, B.C., Building Construction, Laxmi Publications (P) Ltd., 1993





5. Peurifoy, R.L., Form work for Concrete Structures, McGraw Hill Book Co., 1999.
6. Shetty, M.S., Concrete Technology, S.Chand and Company., 2011
7. Neville A.M., Properties of Concrete, Fourth edition, Pearson Education Ltd. 2004.

### **Course outcomes**

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

1. Distinguish the different construction materials and select appropriate materials for construction
2. Design suitable concrete mixes and test the concrete
3. Execute construction jobs with the knowledge of the different construction techniques and building services
4. Identify the building defects and apply suitable repair techniques to rectify them

## **CEMI11 SURVEYING PRACTICES**

### **Course Learning Objectives**

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

### **Course content**

Surveying – Definition – Objectives and Principles – Types of surveying - Conventional and Advanced Surveying – Drawing practices – Map – Plan – Scale – Layout – Field record – Plans of survey – Standard and Calibration – Survey marks

Datums – Reference planes – Geoid – Ellipsoid – Coordinate systems – Coordinate Transformation – Maps – Map Projections and Transformations – Coordinate systems and Map projections of various countries

Conventional Surveying procedures – Data acquisition – Chain – Tape – Theodolite – Levelling – Output, Applications and importance

Modern Surveying procedures – Data acquisition – Remote Sensing - Photogrammetry – EDMs – Space Geodesy – GPS/GNSS – VLSI – Doppler methods – Output, Applications and importance

Digital data and Software – Data structure – Data flow – Exchange and Standards – Creation and gathering of data – Management of Data – Digital image processing – Future – Land surveying Law and Administration – GIS – Survey resource systems



## References

1. *Duggal, S.K. Surveying Vol. I and II, Tata McGraw Hill, 2004.*
2. *Punmia, B.C. Surveying Vol.I and II, Standard Publishers, 1994.*
3. *Arora, K. R. Surveying Vol. I and II, Standard Book House, 1996*

## Course outcomes

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

1. carry out preliminary surveying in the field of civil engineering
2. plan a survey, taking accurate measurements, field booking, plotting and adjustment of traverse
3. use various conventional instruments involved in surveying with respect to utility and precision
4. plan a survey for applications such as road alignment and height of the building
5. undertake measurement and plotting in civil engineering

## CEMI12 STRUCTURAL ANALYSIS AND DESIGN

### Course Learning Objectives

1. To introduce the concept of structural elements and their analysis
2. To understand and design simple axially loaded RC columns and beams
3. To understand and design simple axially loaded Steel columns and beams

### Course content

Introduction to reinforced concrete elements – Analysis and design of axially loaded column - Analysis and design of determinate beams

Analysis and design of laterally restrained and unrestrained steel beams

Analysis and design of axially loaded compression member

Design of lap and butt joints using bolts and welds

### References

1. *Dayaratnam, P., Design of Reinforced Concrete Structures, Oxford & IBH Publishers & Co., New Delhi, 2005.*
2. *IS456-2006 Code of practice for Plain and reinforced concrete code of practice.*
3. *Bhavikatti, S.S., Design of Steel Structures, I.K. International Publishing House Pvt. Ltd., New Delhi, 2010*
4. *IS 800 - 2007, Code of practice for general construction in steel, Bureau of Indian Standards, New Delhi.*
5. *SP6 (1)-1964, IS hand book for structural Engineers. Bureau of Indian Standards, New Delhi.*

### Course outcomes

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

1. Analyse and design simple structural elements



2. Analyse and design simple axially loaded RC columns and beams
3. Analyse and design simple axially loaded Steel columns and beams

### **CEMI13 SOIL AND FOUNDATION**

#### **Course Learning Objectives**

1. To explain how soils are formed and its classification
2. To emphasis the importance of identifying problematic soil and ground improvement
3. To explain the mechanism of soil slope failures
4. To emphasize the importance of soil investigations including destructive and non-destructive methods
5. To explain how to select a suitable foundation system for various site conditions

#### **Course content**

Origin, formation and classification of Soil – Structure and properties of clay minerals - Problematic Soils – Permeability and seepage – Permeability testing of soils and applications

Introduction to compaction and Consolidation – suitability of soil for foundations – methods of ground improvement

Soil slopes and its failure mechanisms – Types - infinite slopes – finite slopes – slope protection measures

Soil exploration and its importance - Plate load test, static and dynamic penetrations tests - geophysical explorations

Types and Choice of foundation – Combined Foundation – Mat foundation – Types of piles and sheet piles – Under reamed piles - machine foundation.

#### **References**

1. Murthy, V.N.S, A text book of Soil Mechanics and Foundation Engineering, UBS Publishers & Distributors Pvt. Ltd., New Delhi 1999.
2. Punmia, B.C., Soil Mechanics and Foundation Engineering, Laxmi Publications Pvt. Ltd., New Delhi, 1995.
3. Gopal Ranjan and Rao, Basic and Applied Soil Mechanics, New Age International (P) Limited, New Delhi, 2002.
4. Robert D. Holtz, William D. Kovacs and Thomas C. Sheahan, An Introduction to Geotechnical Engineering, Pearson, 2013.

#### **Course outcomes**

Upon completion of this course, the students will be able to

1. Understand the importance of geotechnical engineering in civil engineering
2. decide the type of foundation suitable for a particular soil condition
3. select the right method to improvement the problematic soil
4. Understand the importance of soil investigation for any civil engineering construction



## CEMI14 TRANSPORTATION SYSTEMS

### Course Learning Objectives

1. To study about the geometric design of highways
2. To know about pavement materials and design
3. To study about the types and functions of track, junctions and railway stations.
4. To learn about the aircraft characteristics, planning and components of airport.
5. To study about the types and components of docks and harbours.

### Course Content

Highway Engineering - Classification of roads, highway alignment and surveys; Geometric Design - Cross section elements, sight distance, design of horizontal and vertical alignment.

Pavement Materials and Design - Specifications and tests on pavement materials, pavement design factors, design of flexible and rigid pavements.

Railway Engineering - Location surveys and alignment - Gauges - Components of Permanent way; Track Junctions - Points and crossings - Railway stations and yards.

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

Docks and Harbours - Layout and planning principles - Breakwaters – Docks - Wharves and quays - Navigational aids.

### References

1. *Khanna, S.K and Justo, C.E.G., Highway Engineering, Nem Chand and Bros.Roorkee (U.P), 1998.*
2. *M.M. Agarwal, Railway Engineering, Prabha & Co. 2007.*
3. *Khanna, S.K. and Arora, M.G. Airport Planning and Design, Nemchand and Bros. 1999.*
4. *Oza and Oza, Elements of Dock and Harbour Engineering, Charotar Publishing House, 1996.*

### Course Outcomes

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

1. Design cross section elements, sight distance, horizontal and vertical alignment
2. Determine the characteristics of pavement materials
3. Plan the layout of railway terminals
4. Apply principles of airport planning
5. Implement the layout of harbours



## **CEMI15 WATER AND AIR POLLUTION MANAGEMENT**

### **Course Learning Objectives**

1. To understand and determine the basic characteristics of water both qualitatively and quantitatively
2. To expose the students to understand the water distribution system and the water treatment processes
3. To provide adequate knowledge about wastewater characteristics and its treatment processes
4. To give an idea about the disposal of wastewater into water bodies and their effects on river systems
5. To study the various treatment techniques for industrial wastewater and understand the concepts of air pollution and its control measures

### **Course content**

Physical, chemical and biological characteristics of water - water analysis- IS and WHO standards- Requirements of water supply – per capita water demand - Sources of water- Water treatment plants - process of treatments. Water distribution - Methods of distribution systems-Layouts - Analysis of distribution networks. Wastewater characteristics - wastewater treatment - primary treatment - Secondary treatment. Disposal standards - self-purification of rivers - Streeter Phelps equation - oxygen sag curve. Industrial wastewater treatment - methods - Air pollution – effects - stack emission - automobile exhaust - control devices.

### **References**

1. Manual on Water supply and Treatment - CPHEEO, 1999.
2. Peavy H. S., Rowe D. R. and Tchobanoglous G., Environmental Engineering, McGrawHill, New York, 1985.
3. Birdie, G.S. and Birdie, Water Supply and Sanitary Engineering, Dhanpat Rai & Sons, 1992.
4. Duggal, K.N. Elements of Environmental Engineering, S.Chand & Co, 2002.
5. Punmia B.C, Ashok Jain & Arun Jain, Water Supply Engineering, Laxmi Publications, Pvt. Ltd., New Delhi, 2004.
6. Metcalf and Eddy, Wastewater Engineering, Collection, Treatment and Disposal, Tata McGraw Hill, Inc., New York, 2005.

### **Course outcomes**

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

1. Identify the source of water and to calculate water demand.
2. Apply the water treatment concept and methods.
3. Prepare a layout of water distribution network.
4. Characterize wastewater and apply suitable treatment process.
5. Apply the various air pollution control devices to minimize the release of harmful gases into the atmosphere.



## **CEMI16 IRRIGATION ENGINEERING AND MANAGEMENT**

### **Course Learning Objectives**

1. To understand the basic types of irrigation, irrigation standards and crop water assessment
2. To know the irrigation management practices of the past, present and future
3. To study the different aspects of design of hydraulic structures
4. To provide knowledge on various hydraulic structures

### **Course Content**

Irrigation – Need and mode of irrigation – Merits and demerits of irrigation – Crop and crop seasons – consumptive use of water – Duty – Factors affecting duty – Irrigation efficiencies – Planning and Development of irrigation projects. Canal irrigation – Lift irrigation – Tank irrigation – Flooding methods – Merits and demerits – Sprinkler irrigation – Drip irrigation

Weirs – elementary profile of a weir – weirs on pervious foundations - Types of impounding structures - Percolation ponds – Tanks, Sluices and Weirs – Gravity dams – Earth dams – Arch dams – Spillways – Factors affecting location and type of dams – Forces on a dam – Hydraulic design of dams. Alignment of canals – Classification of canals – Canal drops – Hydraulic design of drops – Cross drainage works – Hydraulic design of cross drainage works – Canal Head works – Canal regulators – River Training works. Need for optimisation of water use – Minimising irrigation water losses – On farm development works - Participatory irrigation management – Water users associations – Changing paradigms in water management – Performance evaluation.

### **References**

1. Asawa, G.L., “Irrigation Engineering”, New Age International Publishers, 2000
2. Punima B.C. & Pande B.B .Lal Irrigation and Water Power Engineering, Laxmi Publishing, New Delhi 2007
3. Michael, A.M, Irrigation Theory and Practical, Vikas Publishing Pvt Ltd, 2006
4. Gupta, B.L, & Amir Gupta, “Irrigation Engineering”, Satya Praheshan, New Delhi
5. Dilip Kumar Majumdar, “Irrigation Water Management (Principles & Practices)”, Prentice Hall of India (P), Ltd, 2000
6. Basak, N.N, “Irrigation Engineering”, Tata McGraw-Hill Publishing Co. New Delhi, 1999
7. Sharma R.K.. “Irrigation Engineering”, S. Chand Limited, 2008

### **Course outcomes**

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

1. Find the crop water requirement for various crops in the command area.
2. Understand the complete design of Dams and channel systems.
3. Understand the different types of cross drainage works.
4. Understand the participatory irrigation management



## **CEMI17 ESTIMATING, COSTING AND VALUATION**

### **Course Learning Objectives**

1. To know the importance of preparing the types of estimates under different conditions
2. To know about the rate analysis and bill preparations
3. To study about the specification writing
4. To understand the valuation of land and buildings

### **Course Content**

Preparation of detailed estimates - Preparation of specifications report accompanying the estimate Approximate methods of Costing - types of estimate - costing for various structures - rate analysis - rate for material and labour - schedule of rates -data sheets - abstract estimate. Values and its kinds - Valuation - purpose- scope - methods - land and building method - Factors affecting the value of plot and building - depreciation - Valuation of residential building with case study.

### **References**

1. *Dutta. B.N, Estimating and Costing in Civil Engineering: Theory and Practice including specifications and valuation, UBS Publishers and distributors, 27<sup>th</sup> revised edition.*
2. *Chakraborti.M, Estimating, Costing, Specification & Valuation in Civil Engineering, UBS Publishers and distributors, 2006.*
3. *Bhasin, P.L., Quantity Surveying, 2<sup>nd</sup> Edition, S.Chand & Co., 2000.*

### **Course outcomes**

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

1. apply different types of estimates in different situations
2. carry out analysis of rates and bill preparation at different locations
3. demonstrate the concepts of specification writing
4. carry out valuation of assets

### **ESSENTIAL PROGRAMME LABORATORY REQUIREMENT (ELR)**

#### **CELR10 STRENGTH OF MATERIALS AND CONCRETE LABORATORY**

### **Course Learning Objectives**

1. To find the Young Modulus, torsional strength, hardness and tensile strength of given specimens
2. To find impact value and crushing value of coarse aggregates
3. To find the compressive strength of concrete cubes and bricks
4. To find stiffness of open coiled and closed coiled springs
5. To find the physical properties of given coarse aggregate, fine aggregate and cement samples

### **Course content**

1. Tests on springs - modulus of rigidity of the spring.
2. Deflection test



3. Stress-strain characteristics of HYSD bars.
4. Young's modulus of the given material (steel or wood) by conducting bending test on simply supported beam.
5. Brinell's, Vickers, Rockwell hardness tester.
6. Normal consistency, fineness, Initial setting and final setting time of cement.
7. Specific gravity, soundness and Compressive strength of Cement.
8. Specific gravity of fine and coarse aggregates.
9. Fineness modulus of fine aggregate and coarse aggregate.
10. Bulking of fine aggregate and water absorption test on coarse aggregate.
11. Concrete mix design (IS method).
12. Tests on Concrete.
13. Compressive and split-tensile strength of concrete.
14. Modulus of Elasticity/stress-strain curve in concrete.
15. Permeability test and NDT Tests (only Demonstration)

### **Course outcomes**

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

1. Evaluate Young Modulus, torsional strength, hardness and tensile strength of given specimens.
2. Determine the strength of coarse aggregates.
3. Find the compressive strength of concrete cubes and bricks.
4. Find stiffness of open coiled and closed coiled springs.
5. Determine the physical properties of given coarse aggregates, fine aggregates and cement samples.

## **CELR11 SURVEY LABORATORY**

### **Course Learning Objectives**

The Lab sessions would include experiments on

1. Introduction to Chain Surveying and Compass Surveying.
2. Plane Table Surveying – Radiation, intersection, Traverse, Resection Leveling.
3. Tacheometry and Theodolite survey
4. Trigonometric levelling to determine heights/elevations.
5. Total Station.

### **Course content**

1. Chain and Compass surveying
2. Plane table surveying
3. Leveling: Fly leveling and contouring





4. Radiation, intersection-Traverse- Resection
5. Theodolite surveying
6. Single and two plane observation of trigonometric leveling
7. Determination of Tacheometric Constants
8. Tangential Tacheometry
9. Subtense Bar
10. Total station

### **Course outcomes**

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

1. Use conventional surveying tools such as chain/tape, compass, plane table, level in the field of civil engineering applications such as structural plotting and highway profiling.
2. Apply the procedures involved in field work and to work as a surveying team.
3. Plan a survey appropriately with the skill to understand the surroundings.
4. Take accurate measurements, field booking, plotting and adjustment of errors can be understood.

### **CELR12 FLUID MECHANICS LABORATORY**

#### **Course Learning Objectives**

1. To understand the flow measurement in a pipe flow
2. To determine the energy loss in pipe flow
3. To study the characteristics of turbines
4. To study the characteristics of pumps
5. To measure the discharge in a open channel flow

#### **Course Content**

1. Determination of pipe friction
2. Calibration of flow meters - Venturimeter and Orifice meter
3. Determination of discharge coefficients for notches
4. Determination of minor losses
5. Pressure gauge calibration.
6. Centrifugal pump
7. Submersible pump
8. Reciprocating pump
9. Jet pump
10. Gear pump
11. Screw pump
12. Francis Turbine



### **Course outcomes**

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

1. measure discharge in pipes
2. determine the energy loss in conduits
3. demonstrate the characteristics curves of pumps
4. demonstrate the characteristics curves of turbines
5. carry out discharge measurements in open channel

### **CELR13 ENVIRONMENTAL ENGINEERING LABORATORY**

#### **Course Learning Objectives**

1. To analyze the physical and chemical characteristics of water and wastewater
2. To quantify the chemical requirement for turbidity removal
3. To familiarize the methods to estimate the organic strength of wastewater
4. To study the growth of microorganisms and its quantification

#### **Course Content**

Physical characteristics of water –turbidity, suspended solids. Chemical characteristics of water– pH, hardness, alkalinity, chlorides, sulphates, iron, residual chlorine, total solids, dissolved solids, organic and inorganic solids, DO, BOD, COD. Optimum coagulant dose-Bacteriological tests – Microscopic tests.

#### **Course Outcomes**

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

1. apply different analysis techniques for the measurement of physical and chemical parameters of wastewater
2. quantify the pollutant concentration in water and wastewater
3. recommend the degree of treatment required for the water and wastewater
4. assess the microbial contamination in water

### **CELR14 GEOTECHNICAL ENGINEERING LABORATORY**

#### **Course Learning Objectives**

1. To estimate index properties of soils (coarse and fine)
2. To estimate consistency limit of fine grained soils
3. To estimate shear strength of soils by direct shear test, triaxial shear test, vane shear test & unconfined compressive test
4. To estimate the engineering properties of the soils by density test, CBR test permeability test and consolidation test

#### **Course content**

1. Grain Size analysis.
2. Consistency limits
3. Specific gravity.
4. Permeability tests



5. Unconfined compression test.
6. Direct shear test.
7. Core cutter and sand replacement
8. Compaction test
9. California bearing ratio test
10. Vane shear test.
11. Tri-axial test
12. Consolidation test

### References

1. *Gopal Ranjan Rao, P. Basic and Applied Soil Mechanics, New Age International Pvt. Limited, New Delhi, 2002.*
2. *Murthy, V.N.S., A text book of Soil Mechanics and Foundation Engineering, UBSnPublishers Distributors Ltd., New Delhi, 1999*
3. *Punmia, B.C. Soil Mechanics and Foundation Engineering, Laxmi Publications Pvt. Ltd., New Delhi, 1995.*
4. *Braja M. Das, Fundamentals of Geotechnical Engineering, Thomson Asia Pvt. Ltd., Singapore, 2005.*

### Course outcomes

Upon completion of this course, the students will be able to

1. Proper soil classification and comments its suitability construction
2. Estimate soil consistency and compaction characteristics
3. Estimate soil design parameter for strength estimation
4. Proper interpretation among the estimated soil design parameters

## CELR15 BUILDING PLANNING AND DRAWING

### Course Learning Objectives

1. To understand the principles of planning and bylaws
2. To draw plan, elevation and section of load bearing and framed structures
3. To draw plan, elevation and section of public and industrial structures
4. To prepare detailed working drawing for doors, windows, etc.

### Course Content

Classification of buildings - Principles of planning - Dimensions of buildings - Building bye-laws for floor area ratio, open spaces - Orientation of buildings - Lighting and Ventilation- Planning and preparing sketches and working drawings of Residential buildings (Flat and sloping roof), Schools, Hostels, Hospitals, Single-storey factory buildings with trusses. Detailed working drawings of the component parts - Doors and Windows - Roof Trusses - Staircases-Toilets

### References

1. *Shah M.G. Kalec. M. & Patki SY Building Drawing, Tata Mcgraw Hill, New Delhi, 2000*



### **Course outcomes**

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

1. apply the principles of planning and bylaws used for building planning
2. draw plan, elevation and section for various structures

### **CELR17 COMPUTATIONAL LABORATORY**

#### **Course Learning Objectives**

1. To learn the software developing skills for structural design.
2. To understand the computing techniques in the field of transportation.
3. To gain knowledge in problem solving in water resources.
4. To learn the software skills in structural engineering, transportation engineering, water resources engineering, geotechnical engineering and GIS and Remote Sensing.

#### **Course Content**

Solution of the following problems using MATLAB / C language / Excel

1. Design of the structural elements in concrete and steel.
2. Development of simple programs for solving Transportation Engineering problems: Highway geometrics, pavement design.
3. Development of simple programs for solving Geotechnical Engineering problems: Earth pressure, Foundation settlement and stress analysis, Consolidation.
4. Problems in Environmental and Water resources engineering: Treatment systems, Pipe networks analysis, Synthetic Unit hydrograph derivation, Flood routing, Water balance model.

Analysis, Design and Detailing packages in Structural Engineering, Transportation Engineering, Environmental and Water Resources , Geotechnical Engineering and GIS and Remote sensing applications

#### **References**

1. *Rajasekaran S, Computational Structural Mechanics, Prentice Hall of India, New Delhi, 2001.*
2. *Manickaselvam V.K., Elements of Matrix and Stability Analysis of Structures, Khanna Publishers, New Delhi, 1998.*

### **Course outcomes**

1. Apply the software skills in the transportation engineering, water resources and environmental engineering.
2. Apply computing skills to geotechnical engineering.

### **CELR19 ESTIMATION, COSTING AND VALUATION**

#### **Course Learning Objectives**

1. To know the importance of preparing the types of estimates under different conditions



2. To know about the rate analysis and bill preparations
3. To study about the specification writing
4. To understand the valuation of land and buildings

### **Course Content**

Preparation of detailed estimates - Preparation of specifications report accompanying the estimate Approximate methods of Costing - types of estimate - costing for various structures - rate analysis - rate for material and labour - schedule of rates -data sheets - abstract estimate. Values and its kinds - Valuation - purpose- scope - methods - land and building method - Factors affecting the value of plot and building - depreciation - Valuation of residential building with case study.

### **References**

1. *Dutta, Estimating and Costing in Civil Engineering, S. Datta & Co, 2002.*
2. *Bhasin, P.L., Quantity Surveying, 2<sup>nd</sup> Edition, S.Chand & Co., 2000.*

### **Course outcomes**

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

1. apply different types of estimates in different situations
2. carry out analysis of rates and bill preparation at different locations
3. demonstrate the concepts of specification writing
4. carry out valuation of assets

## **ADVANCED LEVEL COURSES FOR B.Tech. (HONOURS)**

### **CEHO10 BASIC STRUCTURAL DYNAMICS**

#### **Course Learning Objectives**

1. To introduce the concepts of dynamic systems
2. To study the dynamic response of SDOF
3. To study the dynamic response of MDOF
4. To introduce the continuous systems subjected to different types of dynamic loads
5. To learn free and forced vibrations response of structural systems

#### **Course Content**

Dynamic analysis - Elements of vibratory systems and simple Harmonic Motion- Mathematical models of SDOF systems - Principle of Virtual displacements - Evaluation of damping resonance.

Fourier series expression for loading - (blast or earthquake) - Duhamel's integral - Numerical evaluation - Expression for generalized system properties - vibration analysis Rayleigh's method - Rayleigh - Ritz method.

Differential equation of motion - Beam flexure including shear deformation and rotatory inertia - Vibration analysis using finite element method for beams and frames

Evaluation of structural property matrices - Natural vibration - Solution of the eigen value problem - Iteration due to Holzer and Stodola

Idealization of multi-storeyed frames - analysis to blast loading - Deterministic



analysis of earthquake response - lumped SDOF system - Design of earthquake resistant structures.

### References

1. Mario Paz, *Structural Dynamics*, CBS, Publishers, 1987.
2. Roy R Craig, Jr., *Structural Dynamics*, John Wiley & Sons, 1981.
3. Chpora A.K. “*Dynamics of Structures Theory and Application to Earthquake Engineering*” Pearson Education, 2001.

### Course outcomes

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

1. apply the concepts of dynamic systems
2. identify, formulate and solve dynamic response of SDOF
3. identify, formulate and solve dynamic response of MDOF
4. analyze continuous systems subjected to different types of dynamic loads
5. identify, formulate and solve free and forced vibrations response of structural systems

## CEHO11 BASICS OF FINITE ELEMENT METHODS

### Course Learning Objectives

1. To study the strain – displacement and linear constitutive relation
2. To understand the numerical techniques applied in FEM
3. Establishment of element stiffness and load vector
4. To study about the 2-D isoparametric concepts
5. To analyze the 2-D frame elements using FEM techniques

### Course Content

Differential equilibrium equations - strain displacement relation - linear constitutive relation - special cases - Principle of stationary potential energy - application to finite element methods - Some numerical techniques in finite element Analysis

Displacement models - convergence requirements. Natural coordinate systems - Shape function. Interpolation function. Linear and quadratic elements - Lagrange & Serendipity elements. Strain displacement matrix - element stiffness matrix and nodal load vector

Two dimensional isoparametric elements - Four noded quadrilateral elements - triangular elements. Computation of stiffness matrix for isoparametric elements - numerical integration (Gauss quadrature) Convergence criteria for isoparametric elements.

Assemblage of elements – Direct stiffness method. Special characteristics of stiffness matrix - Boundary condition & reaction - Gauss elimination and LDLT decomposition. Basic steps in finite element analysis.

Analysis of framed Structures: 2D – truss element - 2D - beam element. Analysis of plate bending- displacement functions - plate bending Elements. Plane stress and plane strain analysis: Triangular elements - Rectangular elements



## References

1. *Krishnamoorthy, C.S, Finite Element Analysis Theory & Programming, McGraw- Hill, 1995.*
2. *Desai C.S and Abel, J.F., Introduction to the finite element Method, Affiliated East west Press Pvt. Ltd. New Delhi 2000.*

## Course outcomes

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

1. demonstrate the differential equilibrium equations and their relationship
2. apply numerical methods to FEM
3. demonstrate the displacement models and load vectors
4. compute the stiffness matrix for isoperimetric elements
5. analyze plane stress and plane strain problems

## CEHO12 ELEMENTARY THEORY OF ELASTICITY AND INTRODUCTION TO PLASTICITY

### Course Learning Objectives

1. To understand the basic concepts of deformation and strains
2. To know about the 3D stress and strain transformation
3. To know about equations and solution methods in cartesian and polar problems in theory of elasticity.
4. To know the theory of torsion of non-circular sections.
5. To study introduction to plasticity.

### Course content

Basic concepts of deformation of bodies - Notations of stress and strain in 3D field- Transformation of stress and strain in a 3D field.- Equilibrium equations in 2D and 3D Cartesian coordinates.

Plane stress and plane strain problems- 2D problems in Cartesian coordinates as applied to beam bending using Airy's stress function

Problems in 2D -Polar coordinate- Equations of equilibrium and compatibility- Curved beam bending- stress concentration in holes-Semi-infinite solid subjected to different types of loads.

Torsion of non-circular sections- St. Venant's theory – Torsion different cross sections - Prandtl's membrane analogy - Torsion of rolled profiles-Torsion of thin walled tubes

Plasticity – Introduction - Plastic stress strain relations - Different hardening rules - Yield criteria for metals - Graphical representation of yield criteria - Application to thin and thick cylinders under internal pressure.

### References

1. *Timoshenko and Goodier : Theory of Elasticity and Plasticity, McGraw-Hill, 2006*
2. *Mohammed Amin : Computation Elasticity, Narosa Publications,2005*
3. *Chen and Han : Plasticity for Structural Engineers, Springer Verlag,1998.*



4. *K. Bhaskar, T.K. Varadan: Theory of Isotropic/Orthotropic Elasticity, An Introductory Primer, Anne Books Pvt. Ltd. 2009*

### **Course outcomes**

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

1. Understand the concept of deformations and strains
2. understand 3D stress and strain transformations
3. analyse problems in 2D cartesian and polar elasticity problems.
4. analyse torsion problems in non-circular sections.
5. have the basics of plasticity analysis.

### **CEHO14 THEORY OF PLATES AND INTRODUCTION TO SHELLS**

#### **Course Learning Objectives**

1. To understand the assumptions in thin plate analysis
2. To understand the methods of analysis of rectangular plates by Navier's and Levy's method.
3. To study axi-symmetric bending of circular plates.
4. To know the problems of orthotropic and moderately thick plates.
5. to understand the classification and behaviour of shells

#### **Course content**

Thin Plates with small deflection. Laterally loaded thin plates, governing differential equation, various boundary conditions.

Rectangular plates. Simply supported rectangular plates, Navier solution and Levy's method, Rectangular plates with various edge conditions

Axi-symmetric deflections of circular plates.

Analysis of orthotropic plates and moderately thick plates.

Different types of Classification of shells. Structural action of shells. Membrane stresses for cylindrical and conical shells.

#### **References**

1. *Timoshenko, S. and Krieger S.W. "Theory of Plates and Shells", McGraw Hill Book Company, New York, 1990.*
2. *Chandrasekhara K.. "Theory of Plates", Universities Press, 2001*
3. *Szilar, R., "Theory and Analysis of Plates", Prentice Hall Inc., 1995.*

#### **Course outcomes**

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

1. understand the basic assumptions in thin plate analysis.
2. understand the different method like Navier's and Levy's methods for rectangular plates.
3. analyse circular plates subjected to different types of axi-symmetric loads..





4. Analyse orthotropic and moderately thick plates
5. understand the classification and behaviour of shells.

### **CEHO15 THEORIES OF TRAFFIC FLOW**

#### **Course Learning Objectives**

1. To be introduced to traffic flow theory.
2. To study macroscopic modelling
3. To learn microscopic modelling
4. To study car following models
5. To learn the fundamentals of ITS.

#### **Course Content**

Traffic stream parameters - Fundamental diagram of volume-speed-density surface. Counting and Interval Probability distributions. Gap acceptance concepts and their application.

Macroscopic models - Heat flow and fluid flow analogies - Shock waves and bottleneck control approach.

Microscopic models - Application of queuing theory - Queue discipline - Waiting time in single channel queues and extension to multiple channels.

Linear and non-linear car following models - Determination of car following variables - Acceleration noise.

Intelligent Transportation Systems - Area Traffic Control – Automatic Toll Collection – Smart Cards – Collision Detection System.

#### **References**

1. Drew, D.R., *Traffic Flow Theory and Control*, McGraw Hill., 1978.
2. TRB, *Traffic Flow Theory - A Monograph*, SR165, 1975.
3. Burrough P.A. and Rachel A. McDonell, *Principles of Geographical Information Systems*, Oxford Publication, 2004.
4. Sussman, J. M., *Perspective on ITS*, Artech House Publishers, 2005.

#### **Course Outcomes**

Upon completion of this course, the student will be able to:

1. analyze the traffic stream parameters
2. demonstrate fluid flow modeling
3. apply the queuing theory
4. implement car following models
5. define the significance of ITS under Indian conditions.

### **CEHO16 PAVEMENT CONSTRUCTION AND MANAGEMENT**

#### **Course Learning Objectives**

1. To learn the concept of flexible pavement construction
2. To learn the concept of flexible pavement construction
3. To study about the stabilization, recycling and use of geosynthetics



4. To study the structural and functions failure
5. To understand the concept of Pavement Management System

### **Course Content**

Flexible Pavement Construction: Earthwork, compaction and construction of embankments, specifications of materials, construction methods and field control checks for various types of flexible pavement materials in sub-base, base, binder and surface course layers and their choice.

Cement Concrete Pavement Layers: Specifications and method of cement concrete pavement construction; Construction of interlocking block pavements, Quality control tests; Construction of various types of joints.

Soil Stabilized Pavement Layers: Principles of gradation/proportioning of soil-aggregate mixes and compaction; mechanical, soil-cement, soil-bitumen and soil-lime stabilisation methods. Use of additives, Numerical problems on mix design and applications. Design and construction of surface and sub-surface drainage system for highways and airports, Recycling Techniques in Bituminous Pavements, Use of Geosynthetics in Highway Construction

Pavement Evaluation - Pavement Distress - Functional and structural condition of pavements, Pavement distress survey, Functional condition evaluation of pavements- Roughness, Skid Resistance. Structural evaluation of pavements - non-destructive testing, Benkelman beam and Falling Weight Deflectometer, Pavement strengthening based on deflection as per IRC, Maintenance and rehabilitation techniques.

Pavement Management Systems - Pavement Management Systems- Components, structure, data requirements, Project level and Network level needs, Pavement performance prediction – concepts, modelling techniques, Budget forecasting for maintenance and rehabilitation, Ranking and optimization methodologies, life cycle costing

### **References**

1. *Ronald Hudson W., Ralph Haas and Zeniswki , Modern Pavement Management, Mc Graw Hill and Co*
2. *Yang H. Huang, Pavement Analysis and Design, Pearson Prentice Hall, 2004.*
3. *Yoder and Witzech, Pavement Design, McGraw-Hill, 1982.*

### **Course Outcomes**

Upon completion of this course, the student will be able to:

1. carry out the construction of flexible pavements
2. carry out the construction of rigid pavements and joints
3. use different stabilization methods, recycling techniques and geosynthetics
4. evaluate of the pavements based on the functional and structural characteristics
5. do develop pavement management systems



## CEHO17 SOIL DYNAMICS AND MACHINE FOUNDATIONS

### Course Learning Objectives

1. To explain the significance of dynamic load in machine foundation analysis
2. To explain theory of vibration for different field conditions
3. To explain the principles of machine foundation design for reciprocating and impact machines
4. To explain the concept and method of foundation isolation

### Course content

Introduction - nature of dynamic loads - stress conditions on soil elements under earthquake loading - dynamic loads imposed by simple crank mechanism - type of machine foundations - special considerations for design of machine foundations.

Theory of vibration: general definitions - properties of harmonic motion - free vibrations of a mass- spring system - free vibrations with viscous damping - forced vibrations with viscous damping - frequency dependent exciting force - systems under transient forces - Raleigh's method - logarithmic decrement - determination of viscous damping - principle of vibration measuring instruments - systems with two degrees of freedom.

Criteria for a satisfactory machine foundation - permissible amplitude of vibration for different type of machines - methods of analysis of machine foundations - methods based on linear elastic weightless springs - methods based on linear theory of elasticity (elastic half space theory) - methods based on semi graphical approach - degrees of freedom of a block foundation - definition of soil spring constants - nature of damping - geometric and internal damping - determination of soil constants – methods of determination of soil constants in laboratory and field based on IS code provisions.

Vertical, sliding, rocking and yawing vibrations of a block foundation - simultaneous rocking, sliding and vertical vibrations of a block foundation - foundation of reciprocating machines - design criteria - calculation of induced forces and moments - multi-cylinder engines - numerical example (IS code method).

Foundations subjected to impact loads - design criteria - analysis of vertical vibrations - computation of dynamic forces - design of hammer foundations (IS code method) - vibration isolation - active and passive isolation - transmissibility - methods of isolation in machine foundations.

### References

1. Shamsheer Prakash, Soil Dynamics, McGraw-Hill, 1981.
2. Alexander Major, Dynamics in Soil Engineering, A kademiai, 1980.
3. Sreenivasalu and Varadarajan, Handbook of Machine Foundations, Tata McGraw-Hill, 2007.
4. IS 2974 - Part I and II, Design Considerations for Machine Foundations
5. IS 5249: Method of Test for Determination of Dynamic Properties of Soils

### Course outcomes

Upon completion of this course, the students will be able to



1. Understand the influence of dynamic load in the machine foundation analysis and design
2. Use vibration theory in soil dynamics and ascertain soil behaviour accordingly
3. Do machine foundation analysis and design for reciprocating and impact machines
4. Understand foundation isolation and its significance in machine foundation

## **CEHO18 NUMERICAL MODELLING IN GEOTECHNICAL ENGINEERING**

### **Course Learning Objectives**

1. To explain modelling of soil behaviour considering field aspects
2. To explain constitutive relations in soil modelling
3. To explain material modelling with respect to soil behaviour
4. To give an exposure to numerical methods in geotechnical problems
5. To give hand on experience using geotechnical software

### **Course content**

Modelling of Soil Behaviour: Critical state theory; stress paths within and on the state boundary surface; shear strength of clays related to the critical state concept.

Basic Concept of Continuum Mechanics: Notations; stresses and strains in three dimensions; equations of equilibrium, geometric conditions and constitutive relations.

Material modelling: Elastic models; perfect plasticity models-Coulomb model-Drucker-Prager model; Hardening plasticity models; generalized stress-strain relations and stiffness formulations; cap model in isotropic consolidation test and triaxial shear test; simulation of pore pressure; case studies on implementing the models.

Finite element modelling: Introduction to numerical methods - FEM, FDM, BEM; FEM for 1D and 2D problems; FEM for non-linear problems.

Application of Finite element modelling: Effective stress analysis, seepage and consolidation problems; practical aspects related to foundations, embankments and retaining structures; application examples-use of ABAQUS, PLAXIS, FLAC, MIDAS\_GTS programs etc.

### **References**

1. *Chen, W. F. and Mizuno, E., Nonlinear analysis in Soil Mechanics: theory and Implementation, Elsevier science publishers, 1990*
2. *Fethi Azizi, Applied Analyses in Geotechnics, E and N Spon of Taylor and Francis group, 2000*
3. *Desai, C. S., Elementary Finite Element Method, Prentice-Hall, 1979.*
4. *Owen, D. R. J., Hinton, E, Finite Element in Plasticity: Theory and Practice, Pineridge Press Limited, 1980*
5. *Helwany, S, Applied Soil Mechanics with ABAQUS Applications, John Wiley and Sons, 2007.*
6. *Lewis, R. W., Schrefler, B. A., The Finite Element Method in the Deformation and Consolidation of Porous Media, John Wiley and Sons, 1984*



7. Zienkiewicz, O. C., Chan, A. H. C., Paster, M., Schrefler, B. A., Shiomi, T., *Computational Geomechanics with special reference to earthquake engineering*, John Wiley and Sons, 1999.

### **Course outcomes**

Upon completion of this course, the students will be able to

1. Do proper soil modeling with respect to the soil behaviour
2. Understand the constitute relations
3. Select proper material modeling for the FE analysis
4. Use geotechnical software like PLAXIS, FLAC etc.

## **CEHO19 PHYSICOCHEMICAL METHODS FOR WATER AND WASTEWATER TREATMENT**

### **Course Learning Objectives**

1. To learn the physical, chemical and biological characteristics of water and wastewater.
2. To provide an understanding of various physicochemical methods for treatment of water and wastewater.
3. To explain the limitations, advantages and disadvantages of each unit operations and processes.
4. To study the principle and design of the physical and chemical treatment units used for the removal of undesirable constituents (contaminants) from water and wastewater

### **Course Content**

Water and wastewater quality-Physical, chemical and biological parameters - Water Quality requirement-Water quality indices- wastewater discharge standards. Water and wastewater treatment systems: Physical unit operations -chemical unit processes. Aeration and gas transfer- two film theory. Sedimentation: Settling - Types- design. Coagulation and flocculation: Mixing - coagulation processes-stability of colloids- destabilization of colloids- -transport of colloidal particles- flocculation – types- design. Filtration processes- slow sand filtration- rapid sand filter; mechanism of filtration; modes of operation and operational problems. Adsorption: types-adsorption mechanism- adsorption isotherms- kinetics. Disinfection: kinetics-reactions- practices of water chlorination. Ion Exchange, Membrane Processes: Ultrafiltration- Reverse osmosis- Electrodialysis.

### **References**

1. Weber, W.J. *Physicochemical processes for water quality control*, John Wiley and sons, Newyork, 1983.
2. Peavy, H.S., Rowe, D.R., Tchobanoglous, G. *Environmental Engineering*, McGraw Hills, New York 1985.
3. Metcalf and Eddy, *Wastewater engineering, Treatment and Reuse*, Tata McGraw-Hill, New Delhi, 2003.

### **Course outcomes**

At the end of the course student will be able



1. to evaluate various physical and chemical treatment options for treatment of water and wastewater
2. to explain the mechanism behind the treatment processes and their advantages and disadvantages
3. to design various physico- chemical units for the treatment of water and wastewater
4. to use the modelling concepts in the real field applications

## **CEHO20 BIOLOGICAL TREATMENT OF WASTEWATER**

### **Course Learning Objectives**

1. To learn the fundamentals of process kinetics and bioreactors
2. To study about various biological treatment processes and its operations for the wastewater treatment.
3. To provide the knowledge about the kinetics of biological growth and its application in the design of biological reactors
4. To explain the design principles and operational problems involved in various biological treatment processes

### **Course Content**

Constituents of wastewaters-Sources-Fundamentals of Process Kinetics- Enzyme reactions. Bio reactors- types, Classification, design principles. Design of wastewater treatment systems-Primary, secondary and tertiary treatments- Evaluation of Biokinetic Parameters -Activated Sludge and its process- types- Biological Nitrification and denitrification. Attached Growth Biological Treatment Systems-Trickling Filters- Rotating Biological Contactors. Waste stabilization ponds and Lagoons: Aerobic pond, facultative pond, anaerobic ponds- polishing ponds, aerated Lagoons. Anaerobic processes-Process fundamentals-Standard, high rate and hybrid reactors, Anaerobic filters-Expanded /fluidized bed reactors-Up flow anaerobic sludge blanket reactors, - Expanded granular bed reactors- Two stage/phase anaerobic reactors- Sludge Digestion, Sludge disposal.

### **References**

1. Benefield, L.D. and Randall C.W. Biological Processes Design for wastewaters, Prentice-Hall, Inc. Eaglewood Cliffs, 1982.
2. Grady Jr. C.P.L and Lin H.C. Biological wastewater treatment: Theory and Applications, Marcel Dekker, Inc New York, 1980.
3. Metcalf & Eddy, Inc. Wastewater Engineering, Treatment and Reuse. 3rd Edition, Tata McGraw-Hill, New Delhi, 2003.

### **Course outcomes**

At the end of the course student will be able to

1. describe the range of conventional and advanced biological treatment processes for the treatment of bulk organics, nutrients and micro pollutants.
2. design the biological reactors based on biokinetics



3. select appropriate processes for specific applications, and have some knowledge of practical design considerations.
4. execute and assess the performance of bioreactors in laboratory scale

### **CEHO21 FREE SURFACE FLOW**

#### **Course Learning Objectives**

1. To understand the behaviour free surface flow conditions under varying depths of flow in open channel
2. To analyse the inland navigation behaviour in water ways
3. To design suitable channel sections by understanding the river behaviour
4. To describe the steady and unsteady flows in open channels

#### **Course content**

Derivation of the general one-dimensional equations of continuity, momentum and energy used in open channel flow analysis.

Steady non-uniform flows, channel transitions and controls, hydraulic jumps surges.

Surface profile for gradually varied flow.

Unsteady flow in open channels, method of characteristics, surge formation. Kinematics of waves, flood routing and overhead flow.

Inland navigation: Introduction, Various Requirements of Navigable Waterways, Various Measures Adopted for Achieving Navigability, India's Navigable Waterways.

River Engineering: Classification of Rivers, Causes of Meandering, The Aggrading type of River, Degrading type of River, Cutoffs, river Training, Types of Training Works.

#### **References**

1. *Henderson F.M., Open Channel Flow, Macmillan publishing company, 1966.*
2. *Ven Te Chow, Open channel hydraulics, McGraw-Hill publishers, 2009*
3. *Santhosh Kumar Garg, Irrigation Engineering and Hydraulic Structures, Khanna, Publisher, 2009*
4. *Punmia B.C., Pande B.B. Lal. Irrigation and Water Power Engineering, Laxmi Publications, 2009*

#### **Course outcomes**

1. Basis for understanding the open channel flows
2. Capable of designing different channel regimes due to hydraulic jump, surges and any kind of unsteady conditions.
3. Provides solutions for real time problems in river engineering
4. Able to determine the surface profile for steady and varying flows

### **CEHO22 COMPUTATIONAL FLUID DYNAMICS**

#### **Course Learning Objectives**

1. To understand the basic concepts in turbulence modelling.



2. To provide fundamental knowledge on finite difference/ element and volume methods.
3. To describe the solution methodologies for discretized equations.
4. To develop models using structured and unstructured grids.

### **Course content**

Derivation of flow governing equations; turbulence modeling; modeling approaches for multiphase flow; initial and boundary conditions; wellposedness.

Discretization of the governing equations using finite difference/volume/element methods; concepts of consistency, stability and convergence; template for the discretization of a generic unsteady transport equation.

Solution of discretized equations; direct methods; classical iterative methods; advanced methods for structured matrices; conjugate gradient techniques; multigrid methods.

Solution of coupled equations: methods for compressible flows; evaluation of pressure in incompressible flows; pressure-velocity coupling algorithms.

Structured and unstructured grids; structured grid generation; unstructured grid generation. Benchmarking; calibration.

### **References**

1. *John Anderson, Computational Fluid Dynamics, McGraw-Hill Education, 1999*
2. *Pieter Wesseling, Principles of Computational Fluid Dynamics, Springer series, 2009*
3. *Anil W. Date, Introduction to Computational Fluid Dynamics, Cambridge, 2005*
4. *Charles Hirsch, Numerical computation of internal and external flows, Elsevier, 2007*

### **Course outcomes**

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

1. Develop knowledge on non linear problems
2. Improve knowledge on finite element, difference and volume methods.
3. Provide solution methodologies for real time problems.
4. Develop hydrological and hydrodynamic models.

## **CEHO23 WAVE HYDRODYNAMICS**

### **Course Learning Objectives**

1. To understand the basics of wave motion.
2. To study the different aspects of linear wave theory
3. To enhance the knowledge on wave transformation
4. To provide knowledge on various other wave theories and wave forces

### **Course Content**

Conservation of mass, moment and Energy; Euler Equation – Bernoullis Equation. Potential and Stream function.





Linear wave theory: Governing Equation, Boundary Conditions and solutions, Dispersion relation, Constancy of wave period.

Wave celerity, water particle velocities, accelerations, displacements and pressures. Approximations for deep and shallow water conditions. Integral properties of waves: Mass flux, Energy and energy flux, Group speed, Momentum and momentum flux.

Shoaling, bottom friction and damping, refraction, reflection and diffraction. Wave Breaking: Type of breaking, Surf similarity parameter. Keulegan-Carpenter number, Ursell Parameter, Scattering parameter, Reynolds Number, Currents – Classification and Design criteria

Non breaking wave forces on slender structures – Morison equation; Diffraction theory, source distribution method. Introduction to non-linear wave theories-Stokes, Cnoidal and Solitary wave theory. Mass transport velocity, Introduction to Random and directional waves.

### References

1. Sarpkaya, T. and Isaacson, M., Mechanics of Wave Forces on Offshore Structures, Van Nostrand Reinhold Co., New York, 1981.
2. Dean, R.G. and Dalrymple, R.A., Water wave mechanics for Engineers and Scientists, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1994.
3. Ippen, A.T., Estuary and Coastline Hydrodynamics, McGraw-Hill Book Company, Inc., New York, 1978.
4. Shore Protection Manual Volume I and II, Coastal Engineering Research Centre, Dept. of the Army, US Army Corps of Engineers, Washington DC, 1984.
5. Sorenson, R.M., Basic Coastal Engineering, A Wiley-Interscience Publication, New York, 1978.

### Course outcomes

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

1. Derive the linear wave theory dispersion relationship.
2. Understand the complete details of wave parameters.
3. Understand the concept of wave transformation.
4. Compute wave forces on slender cylindrical members.

