REVISED SYLLABI

FOR

B.E DEGREE (CIVIL ENGINEERING) PROGRAMME

SECOND TO EIGHTH SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2014-2015 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING

(A Government Aided ISO 9001-2008 certified

Autonomous Institution affiliated to Anna University)

MADURAI – 625 015, TAMILNADU

Phone: 0452 – 2482240, 41

Fax: 0452 2483427

Web: www.tce.edu

THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI – 625 015

DEPARTMENT OF CIVIL ENGINEERING

I) Vision

To establish process of learning to meet the global standards for sustainable built environment

II) Mission

We are committed to:

- Provide quality education through innovation in teaching and learning practices meeting the global standards
- Encourage faculty and students to carry out socially relevant and forward looking research
- Offer consultancy services using state of the art facilities fulfilling the needs of the industry and society
- Enable our students, faculty and staff to play leadership roles for the betterment of the society in a sustainable manner

III) Programme Educational Objectives (PEO) for B.E Civil Engineering programme:

PEO1. Graduates of the programme will contribute to the development of sustainable Infrastructure for the betterment of society

PEO2. Graduates of the programme, as an employee of an organization or as an employer, will continuously update their domain knowledge for continuous professional development with focus on research & development and industry interaction

PEO3 Graduates of the programme will accept and create innovations in providing solution for sustainable built environment

PEO4 Graduates of the programme will discharge their duties as professional Civil Engineers with quality and ethics

Consistency of PEOs with Mission of the Department

PEOs/ Mission	M1	M2	M3	M4
PEO 1	-	-	M	S
PEO 2	S	S	S	-
PEO 3	M	M	M	S
PEO 4	M	-	M	M

iv) Programme Specific Outcomes (PSO) for B.E Civil Engineering programme

Graduating Students of B.E. Civil Engineering programme will be able to:

PSO 1: Investigate, Analyze, Plan and Design the problems in multivarious domains of civil engineering

PSO 2: Work with ethical principles and sound managerial skills in the promotion of civil engineering infrastructure keeping in mind, health, safety and sustainability of the society

Programme Outcomes (POs) of B.E. (Civil Engineering)

Graduating Students of B.E. Civil Engineering programme will:

1. Engineering Knowledge: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

2. Problem Analysis: Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.

4. Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.

5. Modern Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The Engineer and Society: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

7. Environment and Sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.

11. Project Management and Finance: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long Learning: Recognize the need for and have the preparation and ability to Engage in independent and life- long learning in the broadest context of technological
Change.

Consistency of PEOs with POs of the programme

PEO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PEO1	M	S	M	L	-	S	S	L	L	M	M	M
PEO2	M	M	M	M	L	S	M	M	S	S	S	S
PEO3	S	S	S	S	M	M	S	M	M	M	L	M
PEO4	S	S	S	S	L	L	M	M	M	M	M	M

Department of Civil Engineering - Schedule of Courses B.E. Degree (Civil Engineering) 2014-15

SEM	Theory						Theory cum Practical	Practical		Special Courses	Credits
	1	2	3	4	5	6	7	8	9	10	
I	Common to All Branches										21
II	14CE210 Engineering Mathematics II (3)	14CE220 Strength of Materials (3)	14CE230 Surveying (3)	14CE240 Engineering Geology (3)	14CE250 Environmental Science (3)	---	14CE270 Building Material and Technology (Theory Cum Practical) (3)	14CE280 Survey lab –I (1)	14CE290 Workshop (1)	---	20
III	14CE310 Fourier Series & Partial Diff. Eqns. III (3)	14CE321 Mechanics of solids (3)	14CE330 Fluid Mechanics (3)	14CE340 Water Supply Engineering (3)	14CE351 Concrete Technology (3)	14CE360 Problem solving using Computer (3)	---	14CE380 CAD (1)	14CE390 Survey lab – II (1)	---	20
IV	14CE410 Mathematics IV (3)	14CE420 Structural Analysis (3)	14CE430 Hydraulics and Hydraulic Machinery (3)	14CE440 Wastewater Engineering (3)	14CE450 Engineering Design (3)	---	14CE470 Professional Communication (Theory Cum Practical) (2)	14CE480 Computer programming lab (1)	14CE490 Fluid Mechanics & Machinery lab (1)	14CE4C1 Capstone Course I (2)	21
V	14CE510 Mathematics V (3)	14CE520 Engineering Hydrology (2)	14CE530 Soil Mechanics (3)	14CE540 Highway and Pavement Engineering (3)	14CEPX0 Prog. Elect. I (3)	---	14CE570 Design of, Masonry, Timber and Steel Elements (3)	14CE580 Materials Testing lab (1)	14CE590 Environmental Engineering lab (1)	---	19
VI	14CE610 Design of RC Elements (3)	14CE620 Railways, Airways and Waterways (3)	14CE630 Foundation Engineering (3)	14CE640 Irrigation and water Resources Engineering (2)	14CEPX0 Prog. Elect. II (3)	14CEGX0 Gen. Elect. (3)	14CE670 Design of Steel Structures (3)	14CE680 Soil and Highway Engg lab (1)	---	---	21
VII	14CE710 Accounting and finance (3)	14CE720 Project Management (3)	14CEPX0 Prog. Elect. III (3)	14CEPX0 Prog. Elect. IV (3)	14CEGX0 Gen. Elect. (3)	---	14CE770 Design of RC Structures (3)	14CE780 Estimation and Costing (1)	---	14CE7C0 Capstone Course II (2)	21
VIII	14CEPX0 Prog. Elect. V (3)	14CEPX0 Prog. Elect. VI (3)	14CEPX0 Prog. Elect. VII (3)	---	---	---	---	14CE880 Project (12)		---	21

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Civil Engineering) Programme

COURSES OF STUDY

(For the candidates admitted from 2014-2015 onwards)

SECOND SEMESTER

Course code	Name of the Course	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
14CE210	Engineering Mathematics II	BS	2	2	-	3
14CE220	Strength of Materials	PC	2	2	-	3
14CE230	Surveying	PC	3	0	-	3
14CE240	Engineering Geology	PC	3	0	-	3
14CE250	Environmental Science	HSS	3	0	-	3
THEORY CUM PRACTICAL						
14CE270	Building Materials and Technology	PC	2	0	2	3
PRACTICAL						
14CE280	Survey Lab 1	PC	-	-	2	1
14CE290	Workshop	PC	-	-	2	1
Total			**15**	**4**	**6**	**20**

BS- Basic Sciences; HSS-Humanities and Social Sciences; ES-Engineering Sciences; PC-Programme Core; PE-Programme Elective; GE-General Elective; OC-One Credit Course; TC-Two Credit Course; SS-Self-Study Course (in the list of Programme Electives)

Note:

1 Hour Lecture/week is equivalent to 1 credit
2 Hour Tutorial/week is equivalent to 1 credit
2 Hours Practical/week is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Civil Engineering) Programme

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2014-2015 onwards)

SECOND SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam	Max. Marks	Terminal Exam	Total
THEORY								
1	14CE210	Engineering Mathematics II	3	50	50	100	25	50
2	14CE220	Strength of Materials	3	50	50	100	25	50
3	14CE230	Surveying	3	50	50	100	25	50
4	14CE240	Engineering Geology	3	50	50	100	25	50
5	14CE250	Environmental Science	3	50	50	100	25	50
THEORY CUM PRACTICAL								
6	14CE270	Building Materials and Technology	3	50	50	100	25	50
PRACTICAL								
7	14CE280	Survey Lab I	3	50	50	100	25	50
8	14CE290	Workshop	3	100	-	100	-	50

Continuous Assessment evaluation pattern will differ from course to course and for different tests. This will have to be declared in advance to students.

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Civil Engineering) Programme

COURSES OF STUDY

(For the candidates admitted from 2014-2015 onwards)

THIRD SEMESTER

Course code	Name of the Course	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
14CE310	Fourier Series and Partial Differentiation Eqns	BS	2	2	-	3
14CE320	Mechanics of Solids	PC	2	2	-	3
14CE330	Fluid Mechanics	PC	3	0	-	3
14CE340	Water Supply Engineering	PC	3	0	-	3
14CE350	Concrete Technology	PC	3	0	-	3
14CE360	Problem Solving using Computer	ES	3	0	-	3
PRACTICAL						
14CE380	Computer Aided Drafting Lab	PC	-	-	2	1
14CE390	Survey Lab - II	PC	-	-	2	1
Total			**16**	**4**	**4**	**20**

*** BS- Basic Sciences; HSS-Humanities and Social Sciences; ES-Engineering Sciences; PC-Programme Core; PE-Programme Elective; GE-General Elective; OC-One Credit Course; TC-Two Credit Course; SS-Self-Study Course (in the list of Programme Electives)*

Note:

1 Hour Lecture is equivalent to 1 credit
2 Hours Tutorial is equivalent to 1 credit
2/3 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Civil Engineering) Programme

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2014-2015 onwards)

THIRD SEMESTER

S.No.	Sub. Code	Name of the subject	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	14CE310	Fourier Series and Partial Differentiation Eqns	3	50	50	100	25	50
2	14CE320	Mechanics of Solids	3	50	50	100	25	50
3	14CE330	Fluid Mechanics	3	50	50	100	25	50
4	14CE340	Water Supply Engineering	3	50	50	100	25	50
5	14CE350	Concrete Technology	3	50	50	100	25	50
6	14CE360	Problem Solving using Computer	3	50	50	100	25	50
PRACTICAL								
7	14CE380	Computer Aided Drafting Lab	3	100	-	100	-	50
8	14CE390	Survey Lab - II	3	100	-	100	-	50

* Continuous Assessment evaluation pattern will differ from subject to subject and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

** Terminal Examination will be conducted for maximum marks of 100 and subsequently be reduced to 50 marks for the award of terminal examination marks.

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Civil Engineering) Programme

COURSES OF STUDY

(For the candidates admitted from 2014-2015 onwards)

FOURTH SEMESTER

Course code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14CE410	Mathematics IV	BS	2	2	-	3
14CE420	Structural Analysis	PC	2	2	-	3
14CE430	Hydraulics and Hydraulic Machinery	PC	3	0	-	3
14CE440	Wastewater Engineering	PC	3	0	-	3
14CE450	Engineering Design	PC	3	0	-	3
THEORY CUM PRACTICAL						
14CE470	Professional Communication	HSS	1	0	2	2
PRACTICAL						
14CE480	Computer Programming Lab	PC	-	-	2	1
14CE490	Materials Testing Lab	PC	-	-	2	1
14CE4C0	Capstone Course I	PC				2
	Total		**14**	**4**	**6**	**21**

*** BS- Basic Sciences; HSS-Humanities and Social Sciences; ES-Engineering Sciences; PC-Programme Core; PE-Programme Elective; GE-General Elective; OC-One Credit Course; TC-Two Credit Course; GS- Guided Study Course (in the list of Programme Electives)*

Note:

1 Hour Lecture is equivalent to 1 credit
2 Hours Tutorial is equivalent to 1 credit
2/3 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Civil Engineering) Programme

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2014-2015 onwards)

FOURTH SEMESTER

S.No.	Sub. Code	Name of the subject	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	14CE410	Mathematics IV	3	50	50	100	25	50
2	14CE420	Structural Analysis	3	50	50	100	25	50
3	14CE430	Hydraulics and Hydraulic Machinery	3	50	50	100	25	50
4	14CE440	Wastewater Engineering	3	50	50	100	25	50
5	14CE450	Engineering Design						
THEORY CUM PRACTICAL								
6	14CE470	Professional Communication	3	50	50	100	25	50
PRACTICAL								
7	14CE480	Computer Programming Lab	3	50	50	100	25	50
8	14CE490	Materials Testing Lab	3	50	50	100	25	50
9	14CE4C0	Capstone Course I						

* Continuous Assessment evaluation pattern will differ from subject to subject and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

** Terminal Examination will be conducted for maximum marks of 100 and subsequently be reduced to 50 marks for the award of terminal examination marks.

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Civil Engineering) Programme

COURSES OF STUDY

(For the candidates admitted from 2014-2015 onwards)

FIFTH SEMESTER

Course code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14CE510	Mathematics V	BS	2	2	-	3
14CE520	Engineering Hydrology	PC	2	-	-	2
14CE530	Geo-technical Engineering	PC	2	2	-	3
14CE540	Highway and Airport Engineering	PC	2	2	-	3
14CEPX0	Programme Elective I	PE	3	-	-	3
THEORY CUM PRACTICAL						
14CE570	Design of Steel, Masonry and Timber Elements	PC	2	0	2	3
PRACTICAL						
14CE580	Materials Testing lab	PC	-	-	2	1
14CE590	Environmental Engineering lab	PC	-	-	2	1
Total			**13**	**6**	**6**	**19**

*** BS- Basic Sciences; HSS-Humanities and Social Sciences; ES-Engineering Sciences; PC-Programme Core; PE-Programme Elective; GE-General Elective; OC-One Credit Course; TC-Two Credit Course; GS- Guided Study Course (in the list of Programme Electives)*

Note:

1 Hour Lecture is equivalent to 1 credit
2 Hours Tutorial is equivalent to 1 credit
2/3 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Civil Engineering) Programme

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2014-2015 onwards)

FIFTH SEMESTER

S.No.	Sub. Code	Name of the subject	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	14CE510	Mathematics V	3	50	50	100	25	50
2	14CE520	Engineering Hydrology	3	50	50	100	25	50
3	14CE530	Geo-technical Engineering	3	50	50	100	25	50
4	14CE540	Highway and Airport Engineering	3	50	50	100	25	50
5	14CEPX0	Programme Elective I	3	50	50	100	25	50
THEORY CUM PRACTICAL								
6	14CE570	Design of Steel, Masonry and Timber Elements	4	50 (Best 2 out of 3 tests)	50 (Both theory & practical part)	100	25	50
PRACTICAL								
7	14CE580	Materials Testing lab	3	50	50	100	25	50
8	14CE590	Environmental Engineering lab	3	50	50	100	25	50

* Continuous Assessment evaluation pattern will differ from subject to subject and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

** Terminal Examination will be conducted for maximum marks of 100 and subsequently be reduced to 50 marks for the award of terminal examination marks.

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Civil Engineering) Programme

COURSES OF STUDY

(For the candidates admitted from 2014-2015 onwards)

SIXTH SEMESTER

Course code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14CE610	Design of RC Elements	PC	2	2	-	3
14CE620	Railways, Airways and Waterways	PC	3	-	-	3
14CE630	Foundation Engineering	PC	2	2	-	3
14CE640	Irrigation and Water Resources Engg.	PC	2	-	-	2
14CE670	Design of Steel Structures	PC	2	2	-	3
14CEPX0	Programme Elective	PE	3	-	-	3
14CEGX0	General Elective	GE	3	-	-	3
THEORY CUM PRACTICAL						
PRACTICAL						
14CE680	Soil and Highway Engg Lab	PC	-	-	2	1
Total			**16**	**6**	**4**	**21**

*** BS- Basic Sciences; HSS-Humanities and Social Sciences; ES-Engineering Sciences; PC-Programme Core; PE-Programme Elective; GE-General Elective; OC-One Credit Course; TC-Two Credit Course; GS- Guided Study Course (in the list of Programme Electives)*

Note:

1 Hour Lecture is equivalent to 1 credit
2 Hours Tutorial is equivalent to 1 credit
2/3 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Civil Engineering) Programme

SCHEME OF EXAMINATIONS
(For the candidates admitted from 2014-2015 onwards)

SIXTH SEMESTER

S.No.	Sub. Code	Name of the subject	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	14CE610	Design of RC Elements	3	50	50	100	25	50
2	14CE620	Railways, Airways and Waterways	3	50	50	100	25	50
3	14CE630	Foundation Engineering	3	50	50	100	25	50
4	14CE640	Irrigation and Water Resources Engg.	3	50	50	100	25	50
5	14CE670	Design of Steel Structures	3	50	50	100	25	50
6	14CEPX0	Programme Elective	3	50	50	100	25	50
7	14CEGX0	General Elective	3	50	50	100	25	50
PRACTICAL								
8	14CE680	Soil and Highway Engg Lab	3	50	50	100	25	50

* Continuous Assessment evaluation pattern will differ from subject to subject and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

** Terminal Examination will be conducted for maximum marks of 100 and subsequently be reduced to 50 marks for the award of terminal examination marks.

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Civil Engineering) Programme

COURSES OF STUDY

(For the candidates admitted from 2014-2015 onwards)

SEVENTH SEMESTER

Course code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14CE710	Accounting and Finance	HSS	2	2	-	3
14CE720	Project Management	PC	2	2	-	3
14CEPX0	Programme Elective I	PE	3	-	-	3
14CEPX0	Programme Elective II	PE	3	-	-	3
14CEGX0	General Elective	GE	3	-	-	3
14CE770	Design of RC Structures	PC	2	2	-	3
14CE7C0	Capstone Course II	PC	2	-	-	2
PRACTICAL						
14CE780	Estimation and Costing Lab	PC	-	-	2	1
Total			**17**	**6**	**2**	**21**

*** BS- Basic Sciences; HSS-Humanities and Social Sciences; ES-Engineering Sciences; PC-Programme Core; PE-Programme Elective; GE-General Elective; OC-One Credit Course; TC-Two Credit Course; GS- Guided Study Course (in the list of Programme Electives)*

Note:

1 Hour Lecture is equivalent to 1 credit
2 Hours Tutorial is equivalent to 1 credit
2/3 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Civil Engineering) Programme

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2014-2015 onwards)

SEVENTH SEMESTER

S.No.	Sub. Code	Name of the subject	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	14CE710	Accounting and Finance	3	50	50	100	25	50
2	14CE720	Project Management	3	50	50	100	25	50
3	14CEPX0	Programme Elective I	3	50	50	100	25	50
4	14CEPX0	Programme Elective II	3	50	50	100	25	50
5	14CEGX0	General Elective	3	50	50	100	25	50
6	14CE770	Design of RC Structures	3	50	50	100	25	50
PRACTICAL								
7	14CE780	Estimation and Costing Lab	3	50	50	100	25	50

* Continuous Assessment evaluation pattern will differ from subject to subject and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

** Terminal Examination will be conducted for maximum marks of 100 and subsequently be reduced to 50 marks for the award of terminal examination marks.

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Civil Engineering) Programme

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2014-2015 onwards)

EIGHTH SEMESTER

Course code	Name of the Course	Category	No. of Hours / Week			credits
			L	T	P	
14CEPX0	Programme Elective I	PE	3	-	-	3
14CEPX0	Programme Elective II	PE	3	-	-	3
14CEPX0	Programme Elective III	PE	3	-	-	3
14CE880	Project	PC	-	-	24	12
PRACTICAL						
	Total		**9**	**-**	**24**	**21**

EIGHTH SEMESTER

S. No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	14CE880	Project	-	100	100	300	75	100

* Continuous Assessment evaluation pattern will differ from subject to subject and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

** Terminal Examination will be conducted for maximum marks of 300 and subsequently be reduced to 100 marks for the award of terminal examination marks.

THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI- 625 015

B.E Degree (Civil Engineering) Programme

CATEGORIZATION OF COURSES

(For the candidates admitted from 2014-2015 onwards)

A. Compulsory Foundation Courses: Credits to be earned: (48-63)

a. Humanities and Social Science (12-15)

S.No	Course Code	Name of the Course	Number of Hours / Week			Credit	Pre requisite (if any)
			L	T	P		
THEORY							
1.	14EG140	English	3	-	-	3	
2.	14CE710	Accounting & Finance	3	-	-	3	
3.	14CE790	Management Theory and Practice	3	-	-	3	
4.	14CE720	Project Management	2	2	-	3	
THEORY CUM PRACTICAL							
1.	14CE470	Professional Communication	1	-	2	2	

b. Basic Science (15-21)

S.No	Course Code	Name of the Course	Number of Hours / Week			Credit	Pre requisite (if any)
			L	T	P		
THEORY							
1.	14MA110	Engg Mathematics I	2	2	-	3	
2.	14PH120	Physics	3	-	-	3	
3.	14CH130	Chemistry	3	-	-	3	
4.	14CE210	Engg Mathematics II	2	2	-	3	
5.	14CE310	Fourier Series & Partial Differential Equations	2	2	-	3	
6.	14CE410	Mathematics IV	2	2	-	3	
THEORY CUM PRACTICAL							
PRACTCIAL							
1.	14PH180	Physics Laboratory	-	-	2	1	
2.	14CH190	Chemistry Laboratory	-	-	2	1	

c. Engineering Science (15-21)

S.No	Course Code	Name of the Course	Number of Hours / Week			Credit	Pre requisite (if any)
			L	T	P		
THEORY							
1.	14CE510	Mathematics V	2	2	-	3	

2.	14ES150	Basics of Civil & Mechanical Engg	2	-	-	2	
3.	14ES160	Basics of Electrical & Electronic Engg	2	-	-	2	
4.	14CE250	Environmental Science	3	-	-	3	
5.	14CE290	Workshop	-	-	2	1	
6.	14CE360	Problem solving using Computer	3	-	-	3	
7.	14CE450	Engineering Design	1	-	2	3	
THEORY CUM PRACTICAL							
1.	14ME170	Engineering Graphics	2	-	2	2	
PRACTCIAL							
1.	14CE480	Computer Programming Lab	-	-	2	1	

d. Elective Foundation Courses (HSS, BS and ES) **Credits to be earned: 06**

B. Core Courses: **Credits to be earned: (63-72)**

S.No	Course Code	Name of the Course	Number of Hours / Week			Credit	Pre requisite (if any)
			L	T	P		
THEORY							
1.	14CE220	Strength of Materials	2	2	-	3	
2.	14CE230	Surveying	2	2	-	3	
3.	14CE240	Engineering Geology	3	-	-	3	
4.	14CE321	Mechanics of Solids	2	2	-	3	
5.	14CE330	Fluid Mechanics	3	-	-	3	
6.	14CE340	Water Supply Engg.	3	-	-	3	
7.	14CE351	Concrete Technology	3	-	-	3	
8.	14CE420	Structural Analysis	2	2	-	3	
9.	14CE430	Hydraulics & Hydraulic Machinery	3	-	-	3	
10	14CE440	Waste Water Engg	2	2	-	3	
11	14CE520	Engg Hydrology	2	-	-	3	
12	14CE530	Soil Mechanics	2	2	-	3	
13	14CE540	Highways and Pavement Engg.	2	2	-	3	
14	14CE610	Design of RC Elements	2	2	-	3	14CE220 14CE420
15	14CE620	Railways, Airways and Waterways	3	-	-	3	
16	14CE630	Foundation Engineering	2	2	-	3	14CE530
17	14CE640	Irrigation and Water Resources Engg.	2	-	-	2	
18	14CE670	Design of Steel Structures	2	2	-	3	14CE220 14CE321 14CE420
19	14CE770	Design of RC Structures	2	2	-	3	14CE220 14CE420

							14CE610
20	14CE4C1	Capstone Course 1				2	
21	14CE7C0	Capstone Course 2				2	
THEORY CUM PRACTICAL							
1.	14CE270	Building Materials & Technology	2	2	-	3	
2.	14CE570	Design of Steel, Masonry and Timber Elements	2	2	-	3	
PRACTCIAL							
1.	14CE280	Survey Lab – I	-	-	2	1	
2.	14CE380	CAD	-	-	2	1	
3.	14CE390	Survey Lab – II	-	-	2	1	
4.	14CE580	Materials Testing Lab	-	-	2	1	
5.	14CE490	Fluid Mechanics & Machinery Lab	-	-	2	1	
6.	14CE590	Environmental Engineering Lab	-	-	2	1	
7.	14CE680	Soil and Highway Engg Lab	-	-	2	1	14CE530 ,14CE540
13.	14CE780	Estimation and Costing	-	-	2	1	

C. Elective Courses: (30-39)

a. Programme Specific Elective **Credits to be earned:12-15**

S.No	Course Code	Name of the Course	Number of Hours / Week			Credit	Pre requisite (if any)
			L	T	P		
THEORY							
1.	14CEPA0	Municipal Solid Waste Management	3	-	-	3	
2.	14CEPB1	Air and Noise Pollution Management	3	-	-	3	
3.	14CEPC0	Finite Element Analysis	3	-	-	3	
4.	14CEPD0	Basics of Remote Sensing	3	-	-	3	
5.	14CEPE0	Dynamics of Structures	3	-	-	3	
6.	14CEPF0	Pre-stressed concrete	2	2	-	3	14CE220, 14CE610
7.	14CEPG0	Repair and Rehabilitation of Structures	3	-	-	3	
8.	14CEPH0	Ground Improvement Techniques	3	-	-	3	14CE530, 14CE630
9.	14CEPJ0	Traffic Engineering & Safety	3	-	-	3	

10	14CEPK0	Environmental Impact Assessment	3	-	-	3	
11.	14CEPL0	Bridge Engineering	3	-	-	3	14CE220, 14CE321, 14CE420, 14CE610, 14CE670, 14CEPF0
12.	14CEPM0	Earth Quake Engineering	3	-	-	3	
13.	14CEPN0	Disaster Mitigation and Management	3	-	-	3	
14.	14CEPP0	Building Planning and Services	3	-	-	3	
15.	14CEPQ0	Construction Management	3	-	-	3	
16.	14CEPR0	Fracture Mechanics	3	-	-	3	
17.	14CEPS0	Instrumentation for Civil Engineering	3	-	-	3	14CE330, 14CE430
18.	14CEPT0	Reinforced Concrete Design	2	2	-	3	14CE220, 14CE420, 14CE610

b. Programme Specific Elective for Expanded Scope

Credits to be earned: 09-12

S.No	Course Code	Name of the Course	Number of Hours / Week			Credit	Pre requisite (if any)
			L	T	P		
THEORY							
1.	14CERA0	Aseismic Design of Structures	3	-	-	3	14CE610, 14CE670, 14CE770
2.	14CERB0	Experimental Techniques and Instrumentation	3	-	-	3	14CE220, 14CE420
3.	14CERC0	Computer Aided Design	3	-	-	3	14CE610, 14CE670 14CEPF0,
4.	14CERD0	Resource and Energy Recovery from Waste	3	-	-	3	
5.	14CERE0	Industrial Wastewater Management	3	-	-	3	14CE440
6.	14CERF0	Sustainable Management of Urban Ecology	3	-	-	3	14CE250, 14CE440
7.	14CERG0	Organizational Behaviour	4	-	-	4	

8.	14CERH0	Construction Equipment Management	2	2	-	3	
9.	14CERJ0	Management of Human Resource, Safety and Quality	4	-	-	4	
10.	14CE1A0	Practical Valuation	1	-	-	1	
11.	14CE1B0	Arbitration and Dispute Resolution	1	-	-	1	
12.	14CE1C0	Durability of Concrete Structures	1	-	-	1	
13.	14CE1D0	Green Construction	1	-	-	1	
14.	14CE1E0	Precast Technology in Buildings	1	-	-	1	
15.	14CE1F0	Framing of Structures and Optimum Foundation Systems	1	-	-	1	
16.	14CE1G0	Large Scale System Planning	1	-	-	1	
17.	14CE1H0	Interior Design	1	-	-	1	
18.	14 CE1J0	Corrosion of RC Structures	1	-	-	1	

C. Interdisciplinary Elective Credits to be earned: 09 -12

a. General Electives

S.No	Course Code	Name of the Course	**Number of Hours / Week**			Credit	Pre requisite (if any)
			L	T	P		
THEORY							
1	14CEGA0	Sustainable Development	3	-	-	3	
2	14CEGB0	Building Services	3	-	-	3	
3	14CEGC0	Disaster Assessment and Mitigation measures	3	-	-	3	
4	14CEGD0	Project Management	2	2	-	3	
5	14CEGE0	Road Safety	3	-	-	3	
6	14CEGF0	Climate Change and Policy	3	-	-	3	

b. Flexible Electives

S.No	Course Code	Name of the Course	**Number of Hours / Week**			Credit	Pre requisite (if any)
			L	T	P		
THEORY							
1.	14CEPT0	Waste Management	3	-	-	3	

2.	14CEPU0	Groundwater Management	3	-	-	3	
3.	14CEPV0	Pre Fabricated Structures	3	-	-	3	

D. Project **Credits to be earned: 12**

E. Skill/Proficiency based Elective **Credits to be earned: 02 -04**

		Category	L	T	P	Credit
14CE210	**ENGINEERING MATHEMATICS II**	BS	2	1	0	3

Preamble

Vector calculus is a form of mathematics that is focused on the integration of vector fields. An Engineer should know the Transformations of the Integrals, as Transformation of Line Integral to surface and then to volume integrals. The Laplace transform method is a powerful method for solving linear ODEs and corresponding initial value problems as well as systems of ODEs arising in Engineering. The knowledge of transformations is to create a new domain in which it is easier to handle the problem that is being investigated. Complex Integration approach is very useful to evaluate many improper integrals of a real variable.

Prerequisite

Differentiation, Integration and Elementary calculus.

Course Outcomes

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

Course Outcomes	Bloom's level	Expected attainment level (%)	Expected Proficiency (grade)
CO1 Find area and volume using double and triple Integral.	Understand	60	C
CO2 Apply the concepts of Differentiation and Integration in Vectors.	Apply	65	B
CO3: Apply Laplace transform technique to solve the given ordinary differential equation.	Apply	60	C
CO4: Predict an analytic function, when its real or Imaginary part is known.	Apply	65	B
CO5: Find the Singularities and its corresponding Residues for the given function.	Understand	70	B
CO6: Predict the suitable method to evaluate the Contour integration.	Understand	70	B

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	**S**	**S**											M	**S**
CO2	M	M	M										**S**	**S**
CO3.	**S**	**S**	**S**										**S**	M
CO4.	**S**	**S**											M	
CO5.	M	M											M	**S**
CO6.	**S**												**S**	

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	30	30	30	20
Apply	60	60	60	70
Analyze	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Predict the value of $\int_0^1\int_0^2\int_0^1 dxdydz$
2. Distinguish between triple integral and volume integral.
3. Estimate the area enclosed by the curves $y = x^2$ and $x + y = 2$
4. Predict the limits of $\int_0^a\int_0^x f(x, y)dydx$, by changing the order of integration.

Course Outcome 2 (CO2):

1. Using Taylor's theorem, show that

$$\log Z = (Z-1) - \frac{(Z-1)^2}{2} + \frac{(Z-1)^3}{3} - ...., where\ |Z-1| < 1$$

2. Using Green's theorem for $\vec{f} = (x^2 + y^2)\,\vec{i}$ - 2xy $\vec{j}$ taken around the rectangle bounded by the lines x=0,x=a, y=0 and y=b.
3. If $f(z) = u(r,\theta) + iv(r,\theta)$ is differentiable at $z = re^{i\theta}$, then show that

$$u_r = \frac{v_\theta}{r}, \ u_\theta = -r\,v_r$$

Course Outcome 3 (CO3):

1. Solve the Equation $y''+9y=\cos 2t, y(0)=1 \,\&\, y\left(\frac{\pi}{2}\right)=-1$ using Laplace Transform.
2. Compute $L^{-1}\left(\frac{p+8}{p^2+4p+5}\right)$

Using convolution theorem in Laplace Transform, evaluate $\int_0^t Sin u Cos(t-u)du$

3. Show that $\int_0^t e^{-4t} t \sin 3t dt = \frac{6}{(s^2+8s+25)^2}$.

Course Outcome 4 (CO4)

1. Compute an analytic function f(z)=u+iv, where $u=e^x(x\cos y - y\sin y)$.
2. Using convolution theorem, compute $L^{-1}\left(\frac{s^2}{(s^2+a^2)(s^2+b^2)}\right)$
3. Show that the map w = 1/z maps the circles and straight lines as circles or straight lines.
4. Demonstrate the Milne Thompson method to construct an analytic function f(z)=u+iv, given either u(x,y) or v(x,y).

Course Outcome 5 (CO5) :

1. Define the term Residue of f(z) at z = a.
2. Give an example of meromorphic function.
3. Identify the singular points of $\frac{1}{(2\sin z-1)^2}$
4. Identify the residue of $\frac{z+1}{z^2-2z}$ at its poles.

Course Outcome 6(CO6):

1. Evaluate (i) $\int_0^{2\pi} \frac{Cos2\theta}{5+4Cos\theta} d\theta$

   (ii) $\int_0^{\infty} \frac{x^2}{(x^2+1)(x^2+4)} dx$

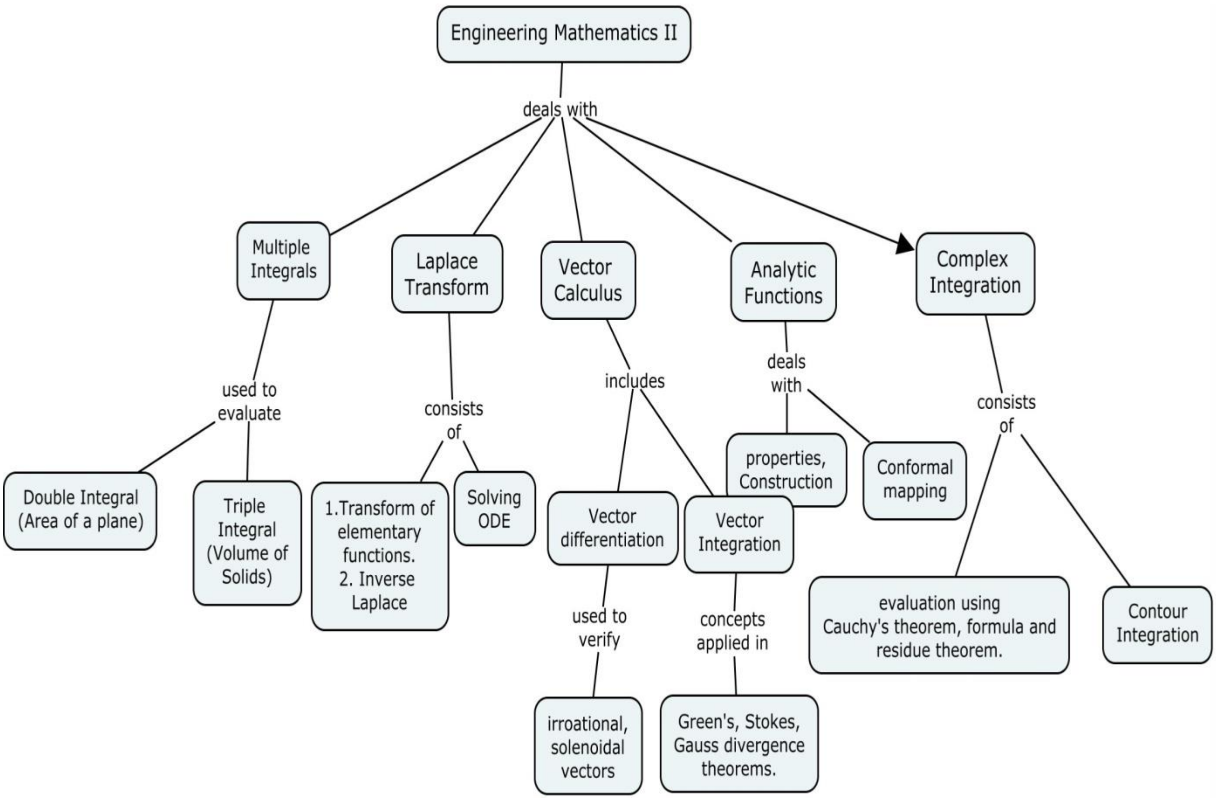
   (iii) $\int_0^{\infty} \frac{x\sin mx}{x^2+a^2} dx$

2. Examine the Laurent's series expansion of $f(z)=\frac{z+4}{(z+3)(z-1)^2}$,

in (i) 0 < |z-1| < 4 (ii) |z-1| > 4

3. Distinguish between isolated singularity and removable singularity.
4. Distinguish between Cauchy's fundamental theorem and Cauchy's fundamental theorem.

Concept Map



Syllabus:

MULTIPLE INTEGRALS: Double integrals –Change of order of integration –Double integrals in polar coordinates –Area enclosed by plane curves –Triple integrals –Volume of Solids –Change of variables in double and triple integrals.

VECTOR CALCULUS: Gradient, divergence and curl –Directional derivative –Irrotational and solenoidal vector fields –Simple problems on Vector differentiation–Vector integration –Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem(excluding proofs)–Simple applications.

LAPLACE TRANSFORM : Laplace transform –Sufficient condition for existence –Transform of elementary functions –Basic properties –Transforms of derivatives and integrals of functions -

Derivatives and integrals of transforms -Transforms of unit step function and impulse functions – Transform of periodic functions. Inverse Laplace transform -Statement of Convolution theorem – Initial and final value theorems–Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques. **ANALYTIC FUNCTIONS :** Functions of a complex variable – Analytic functions: Necessary conditions –Cauchy -Riemann equations and sufficient conditions (excluding proofs) –Harmonic and orthogonal properties of analytic function –Harmonic conjugate – Construction of analytic functions –Conformal mapping: $w = z^2$, sinz, e^z and bilinear transformation.

COMPLEX INTEGRATION : Complex integration –Statement and applications of Cauchy's integral theorem and Cauchy's integral formula –Taylor's and Laurent's series expansions –Singular points – Residues –Cauchy's residue theorem –Evaluation of real definite integrals as contour integrals around unit circle and semi-circle (excluding poles on the real axis).

Text Book

1. Grewal. B.S, "Higher Engineering Mathematics", 41st Edition, Khanna Publications, Delhi, 2011.

2. Erwin Kreyszig, Advanced Engineering Mathematics, 8th Edition, John Wiley & Sons, 2009.

Reference Books

1. T.Veerarajan, Engineering Mathematics, 3rd Edition, Tata McGraw Hill, New Delhi, 2004.
2. Thomas Phinny, Calculus, 13th Edition, Pearson Education, New Delhi,2005.
3. B.V.Ramana, Higher Engineering Mathematics, Tata Macraw Hill, New Delhi,2011

Course content and lecture schedule

Module No.	Topic	No.of Lectures
1	**Multiple Integrals**	
1.1	Double integrals and areas	2
1.2	Triple integrals and volumes	2
	Tutorial	1
1.3	Change of order of integration	1
1.4	Change of variables between Cartesian and polar with applications	2
	Tutorial	1
2	**Vector Calculus**	
2.1	Operators Grad, div and curl with properties	2
2.2	Solenoidal and irrotational vectors	2
	Tutorial	1
2.3	Vector integration(three famous theorems)	3

	Tutorial	1
3	**Laplace Transformation**	
3.1	Laplace transformation-properties, inverse laplace transforms	3
	Tutorial	1
3.2	Periodic functions, convolution theorem, initial value theorem and final value theorem	3
3.3	Solution of differential equations and integral equations	2
	Tutorial	1
4	**Analytic Functions**	
4.1	Analytic functions, C-R equations and properties	2
4.2	Harmonic functions and Milne Thomson's method	2
	Tutorial	1
4.3	Conformal maps and bilinear transformations	3
	Tutorial	1
5	**Complex Integration**	
5.1	Cauchy's theorem and consequences	1
5.2	Evaluating integrals using Cauchy's integral formula	2
5.3	Taylor's and Laurent's expansions	2
	Tutorial	1
5.4	Singularities and Cauchy's residue theorem	1
5.5	Contour integration using unit circle and semicircular contours	3
	Tutorial	1
	Total	**48**

Course Designers:

1. S.Jeyabharathi sjbmat@tce.edu
2. G. Jothilakshmi gjlmat@tce.edu
3. A.P.Pushpalatha appmat@tce.edu

14CE221	STRENGTH OF MATERIALS	Category	L	T	P	Credit
		PC	2	2	0	3

Preamble

A structure is made up of constituent elements like beam, column and membrane. The constituent elements should have adequate size to resist applied loads to build a safe structure. Their size is decided by material properties of the elements, particularly their strength. Man seems to have had information regarding the strength of structural material even in ancient times. They had worked out empirical rules which they used to dimension elements of structures like the pyramid, coliseum, harbors, bridges and aqueducts that bring awe to the beholder even today. The Greek had even developed statics, the foundation of mechanics of materials, and people like Archimedes put this into practice by hoisting huge structural elements and putting them in place. But this ancient knowledge was lost during the middle ages and only during the renaissance the science of material strength was recovered. At that time people like Leonardo da Vinci took mechanics of structures to great heights. He investigated the strength of materials experimentally, the bending of beam and its variation with different lengths and loads. He even investigated the strength of columns.

But the first attempt to find safe dimension for a structural element, analytically, was attempted only in the 17th century. It started with Galileo's famous book on strength and mechanics of materials, called, 'Two New Sciences.' That was the start of Strength of Materials. There was rapid development in the field of mechanics of materials at the end of the 19th century. Testing of materials attracted attention and soon the National Bureau of Standards was born in USA. Research took on a new turn facilitating closer contact between engineers and physicists. Meanwhile in the field of Strength of Materials, refinements in stress analysis, both analytical and experimental took place. Fields like fracture mechanics, stress concentration, ductility, strength theories, fatigue, experimental stress analysis are few among a vast horde of new fields of study that have emerged from a renewed interest in Strength of Materials in twentieth century.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to	Expected Attainment Level in %	Expected Proficiency Level in grade

CO1: **Compute resultant, resolve several concurrent forces and also to apply equilibrium concepts**	**Apply**	**70**	**A**
CO2: **Compute simple stresses and strains**	**Apply**	**70**	**A**
CO3: **Compute principal stresses and strains**	**Apply**	**70**	**A**
CO4: **Practice shear force and bending moment computations and construct shear force and bending moment diagrams**	**Apply**	**70**	**A**
CO5: **Compute geometric properties of sections**	**Apply**	**70**	**A**
CO6: **Compute bending and shear stresses for various sections and plot the variation across the cross section.**	**Apply**	**70**	**A**

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1.	M	M	M	-	-	-	-	S	-	-	-	-	M	L
CO2.	S	S	S	-	-	-	-	-	-	-	-	-	M	L
CO3.	S	S	S	M	-	-	-	-	-	-	-	-	M	L
CO4.	S	S	S	S	-	M	-	S	-	-	-	-	M	L
CO5.	S	S	S	S	-	M	-	-	-	-	-	-	M	L
CO6.	L	L	L	-	-	-	-	-	-	-	-	-	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	10	10	10	10
Apply	80	80	80	80
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Course Level Assessment Questions

1. What are the methods available for finding resultant of two forces?

CO1: Computing resultant and resolution of forces

2. State the polygon rule for finding the resultant of several concurrent forces.

3. Obtain the components of a 5kN force forming angles of 40°, 60° and 110° respectively with x,y and z axes .
4. Determine the magnitude and direction of resultant of the following two forces acting on a bolt. One force is of magnitude 10kN making an angle of 60° with the horizontal axis and pointed right side up and another force of magnitude 15kN making an angle 30° with the horizontal axis and pointed right side down.

CO2: Computing simple stresses and strains

1. Define Poisson's ratios mention its use.
2. A steel bar of rectangular section 25mm x 40mm carries an axial load of 40kN. Determine the average tensile stress over the normal cross section of the bar.
3. A 30m long wire is subjected to a tensile force of 4.45kN. It stretches by an amount of 25mm. Find the modulus of elasticity of the material if the cross sectional area of the wire is 25.8 mm^2.
4. A bar of varying cross–section consists of two sections of lengths. It is subjected to an axial pull F. Find the total elongation.
5. The Young's modulus of a material is 20 MPaand its rigidity modulus is 80 MPa. Determine its bulk modulus
6. A circular rod of 100mm diameter and 500mm length is subjected to an axial force of 2000kN. Determine the modulus of rigidity, Bulk modulus and the change in volume if the Poisson's ratio is 0.30 and Young's modulus is 200 GPa.
7. A bar of 20mm diameter is tested in tension. It is observed that when a load of 40kN is applied, the extension measured over a gauge length of 200mm is 0.15mm and contraction in diameter is 0.004mm. Find the Poisson's ratio and the elastic constants.

CO3: Computing principal stresses and strains

1. Obtain the equations for finding normal and tangential stress for a member subjected to direct stresses in two mutually perpendicular directions accompanied by a shear stress

2. How will you draw Mohr's circle for finding normal and tangential stresses for a body subjected to two mutually perpendicular tensile stresses?

3. The principal stresses at a point in a bar are 160N/mm^2 (tensile) and 80N/mm^2 (compressive). Determine the resultant stress in magnitude and direction on a plane

inclined at 60º to the axis of the major principal stress. Also, determine the maximum

intensity of shear stress in the material at the point

4. At a certain point in a strained material, the stresses on the two planes at right angles to each other are 40N/mm^2 and 20N/mm^2 both tensile. They are accompanied by a shear stress of magnitude 20N/mm2. Determine graphically the location of principal planes and evaluate the principal stresses.

1. Define shear force and bending moment.

CO4: Practice of shear force and bending moment computations and constructing shear force and bending moment diagrams

2. A cantilever beam of span 6m is subjected to a point load of 10kN at free end. Draw the shear force and bending moment diagrams.
3. A simply supported beam of span 6m is subjected to two point loads of 15kN and 20kN at 2m and 4m from left end. Draw the shear force and bending moment diagrams.

CO5: **Computing geometric properties of sections**

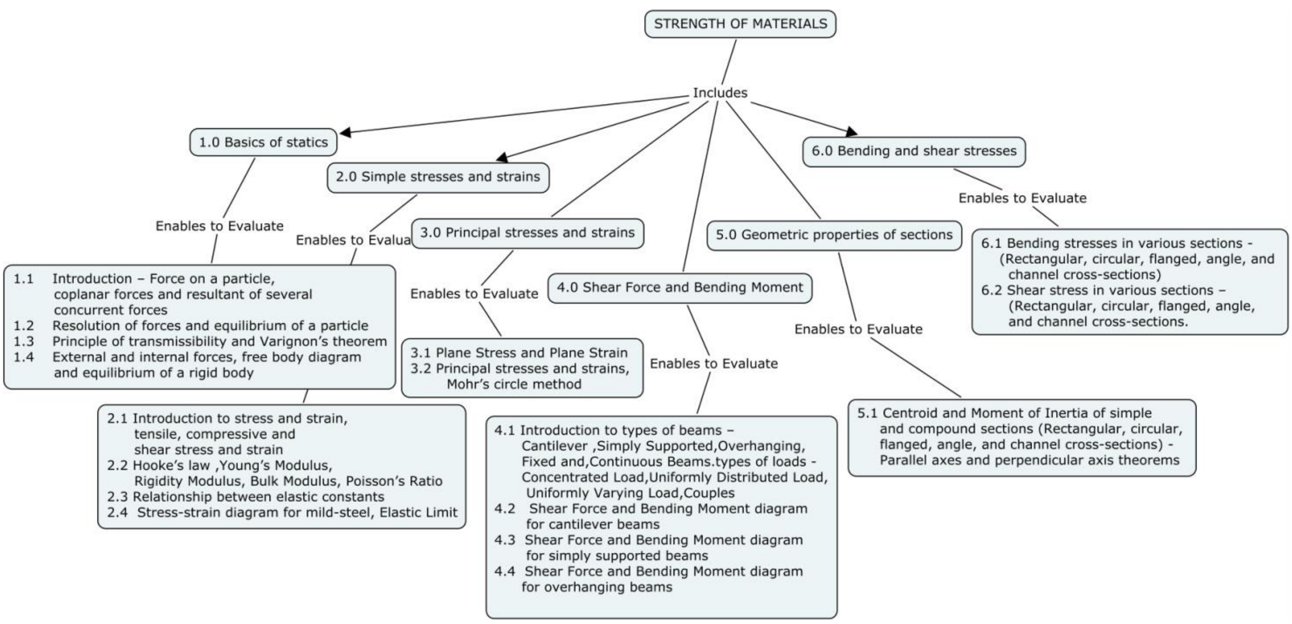
1. State parallel axes theorem.
2. Write the significance of perpendicular axis theorem
3. A unsymmetrical I section is having top flange of size 100mm x 25mm, web of size 20mm x 200mm and bottom flange of size 125mm x 25mm. Compute the moments of inertia about xx and yy axes. Also, determine the radius of gyration

1. **State the assumptions made in the theory of simple bending.**

CO6: Interpretation of bending and shear stresses in various sections and plotting the variation across the cross section.

2. Sketch the bending stress distribution in a simply supported beam of rectangular section.
3. A T-beam having flange dimensions 150mm x 50mm and web dimensions 50mm x 150mm is simply supported over a span of 4m and carries a uniformly distributed load of 2 kN/m over the entire span. Determine the maximum tensile and maximum compressive stress. Also, sketch the bending stress distribution across the cross section.
4. A timber beam is simply supported at its ends and carries a concentrated load at the mid span. The maximum longitudinal stress is 'f' and the maximum shearing stress is q. Find the ratio of the span to depth of the beam ignoring the self-weight of the beam. If f = 12 MPa and q = 1MPa.

Concept Map



Syllabus

Basics of statics : Introduction, force on a particle, coplanar forces, resultant of several concurrent forces, resolution of forces , equilibrium of a particle, principle of transmissibility, Varignon's theorem, external and internal forces, free body diagram, requirements of equilibrium of a rigid body.**Simple Stresses and Strains** : Introduction, stress, strain, tensile, compressive and shear stress – Hooke's law – Young's modulus, rigidity modulus, Bulk modulus, Poisson's ratio, Volumetric strain, relationship between elastic constants. **Principal stresses and strains**: Analysis of plane stress and strain, principal stresses and strains – Mohr's circle. **Shear Force and Bending Moment:** Introduction, types of beams – cantilever, simply supported over hanging, fixed and continuous beams. Types of loads – concentrated load, uniformly distribute load, uniformly varying load and couples. Shear force and bending moment diagram for statically determinate beams (cantilever, simply supported and over hanging). **Geometric properties of sections:** Centroid and moment of inertia of plane areas and compound sections, parallel axes and perpendicular axis theorems, polar moment of inertia and radius of gyration. **Bending and shear stresses:** bending stresses,

shear stresses in various sections.

Text Book

1. **Rajput. R.K., "Strength of Materials", S. Chand Publications, 2010.**

Reference Books

1. **Timoshenko. S.P. and Young D.H., "Elements of Strength of Materials", 5th edition (SI Units), Affiliated East-West Press Ltd., New Delhi, 2012.**
2. **Ferdinand P. Beer and E. Russell Johnston Jr, "Mechanics of Materials", McGraw Hill Book Company, Singapore, 1992.**
3. **Egor. P. Popov, "Mechanics of Materials", Prentice Hall, 1976.**
4. **Bansal, R.K., "A Text Book of Strength of Materials", Laxmi Publications (P) Ltd., New Delhi 2010.**

Module No.	Topic	No. of Lectures
1.0	**Basics of statics**	
1.1	Introduction – Force on a particle, coplanar forces and resultant of several concurrent forces	1
1.2	Resolution of forces and equilibrium of a particle	1
	Tutorial	2
1.3	Principle of transmissibility and Varignon's theorem	1
1.4	External and internal forces, free body diagram and equilibrium of a rigid body	1
	Tutorial	2
2.0	**Simple stresses and strains**	
2.1	Introduction to stress and strain,tensile, compressive and shear stress and strain	1
2.2	Hooke's law ,Young's Modulus, Rigidity Modulus, Bulk Modulus, Poisson's Ratio	1
	Tutorial	2
2.3	Relationship between elastic constants	2
2.4	Stress-strain diagram for mild-steel, Elastic Limit	1
	Tutorial	3
3.0	**Principal stresses and strains**	
3.1	Plane Stress and Plane Strain	2
3.2	Principal stresses and strains, Mohr's circle method	1
	Tutorial	3
4.0	**Shear Force and Bending Moment**	
4.1	Introduction to types of beams – Cantilever ,Simply Supported,Overhanging, Fixed and,Continuous Beams Introduction to types of loads - Concentrated Load,Uniformly Distributed Load,Uniformly Varying Load,Couples	1
4.2	Shear Force and Bending Moment diagram for cantilever beams	2
	Tutorial	2
4.3	Shear Force and Bending Moment diagram for simply supported beams	2
	Tutorial	2
4.4	Shear Force and Bending Moment diagram for overhanging beams	1
	Tutorial	2
5.0	**Geometric properties of sections**	

5.1	Centroid and Moment of Inertia of simple and compound sections (Rectangular, circular, flanged, angle, and channel cross-sections) - Parallel axes and perpendicular axis theorems	2
	Tutorial	2
6.0	**Bending and shear stresses**	
6.1	Bending stresses in various sections - (Rectangular, circular, flanged, angle, and channel cross-sections)	2
	Tutorial	2
6.2	Shear stress in various sections – (Rectangular, circular, flanged, angle, and channel cross-sections)	2
	Tutorial	2
	Total Hours(24 Theory + 24 Tutorials)	**48**

Course Designers:

1. **Dr. B. Sivagurunathan** **sivagurunathan@tce.edu**
2. **Dr. S. Nagan** **nagan_civil@tce.edu**

14CE230	SURVEYING	Category	L	T	P	Credit
		PC	2	2	0	3

Preamble

Surveying is the process of determining by measurement, the relative positions of points on or near the earth surface. The data collected from a survey is used in the preparation of plans, maps, profiles, charts and diagrams. In addition survey may be used for the delineation of property boundaries, computation of areas and volumes also to set out the proposed work on the ground.

Course Outcomes

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

On the successful completion of the course, students will be able to:		Expected Attainment Level in %	Expected Proficiency Level in grade
(CO1) Compute the linear measurement in chain surveying and angular measurements in compass surveying.	**Apply**	**70**	**A**
(CO2) Demonstrate the significance of plane table surveying in preparation of plans	**Understand**	**70**	**A**
(CO3) Find the relative position of points on the ground using levelling principles.	**Apply**	**70**	**A**
(CO4) Find the distance and heights of objects using tacheometric principle	**Apply**	**70**	**A**
(CO5) Compute the volume of cutting and filling using longitudinal and cross sectioning methods.	**Apply**	**70**	**A**
(CO6) Explain the importance of advanced techniques involved in surveying.	**Understand**	**70**	**A**

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO3.	S	S	L	-	-	-	-	-	-	-	-	-	L	-
CO4.	L	L	L	-	-	-	-	L	-	-	-	-	L	L
CO3.	S	S	L	-	-	-	-	-	-	-	-	-	L	-
CO4.	S	S	M	-	-	-	-	-	-	-	-	-	M	-
CO5.	S	S	M	L	-	-	-	L	-	-	-	-	M	L

CO6.	**L**	**L**	**L**	**-**	**L**	**-**	**-**	**-**	**-**	**L**	**-**	**-**	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	30	20	20	20
Understand	30	30	20	20
Apply	40	50	60	60
Analyse	---	---	---	---
Evaluate	---	---	---	---
Create	---	---	---	---

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define surveying and list out its objectives
2. Enumerate the factors to be considered for choosing chain survey.
3. Describe briefly the process of chaining.
4. State the different methods of surveying with prismatic compass.
5. Under what circumstances is a compass traverse suitable?
6. Describe the construction of a prismatic compass with neat sketch and state the functions of its parts.

Course Outcome 2 (CO2):

1. Enumerate the various methods of plane tabling. Discuss the methods of radiation and intersection in detail.
2. List the advantages and disadvantages of plane table survey.
3. State the three point problem in plane tabling and describe how it is solved by Bessel's method.
4. Explain with sketches the different methods of locating a point on the plan by plane table. Discuss the relative merits of these methods.
5. Describe the various components of a plane table. What are their functions?

Course Outcome 3 (CO3)

1. The following consecutive readings were taken with dumpy level, the instrument having been shifted after second, fourth and seventh readings. 0.900,1.250,2.450,1.370,2.945,3.125,3.725,0.105,1.975,2.025 and 1.775. The first reading was taken with a staff held on a benchmark of elevation 100.000m. Enter the readings in a level book and calculate the reduced levels using rise and fall method. Apply usual checks.

2. The following consecutive readings were taken with a level and 5m leveling staff on continuously sloping ground at a common interval of 20m.
   0.385; 1.030; 1.925; 2.825; 3.730; 4.685; 0.625; 2.005; 3.110; 4.485. The RL of the first point was 200m. Calculate the RL of the points by rise and fall as well as height of collimation method. Also find the gradient between first and last point.

3. The following staff readings were observed successively with level, the instrument having been moved forward after the 2nd, 4th and 8th readings.
0.875; 1.235; 2.310; 1.385; 2.930; 3.125; 4.125; 0.120; 1.875; 2.030; 3.765.

The RL of the first point was 150m. Calculate the RL of the points by rise and fall as well as height of collimation method. If the distance between the first and last point was 1500m, find its gradient.

Course Outcome 4 (CO4)

1. The following observation refer to a tacheometric survey. Compute the reduced levels of P, Q and R and the horizontal distances PQ and QR. Assume the tacheometer fitted with anallatic lens.

Inst Stn	Height of axis	Staff at	Vertical angle	Staff readings			Remarks
				Bottom	Middle	Top	
P	1.440	BM	$-2^{0}24'$	1.200	1.830	2.460	RL of BM = 37.725m.
P	1.440	Q	$+4^{0}36'$	1.350	1.820	2.209	Staff being held vertically
Q	1.410	R	$+6^{0}12'$	0.720	1.880	2.040	

2. A tacheometer was set up at a station A and the following readings were obtained on a vertically held staff. The constants of the instruments were 100 and 0.1. Find the horizontal distance from A to B and the reduced level of B.

Station	Staff station	Target reading	Vertical angle	Remarks
A	B	3.500	$+4^{0}20'$	RL of BM = 150.000m and height of instrument at A=1.500m
	B	0.500	$-2^{0}20'$	

3. Find the elevation of the top of chimney from the following data.

Inst Stn	Reading on BM	Angle of elevation	Remarks
A	0.860	$18^{0}36'$	RL of BM=421.380m
B	1.220	$10^{0}12'$	Distance AB = 50m

Stations A and B and the top of chimney are in the same vertical plane.

Course Outcome 5 (CO5)

1. A series of offsets were taken from a chain line to a curved boundary at intervals of 5m in the following order: 1.75, 2.50, 4.75, 5.85, 3.95, 4.90, 6.55 and 5.25m. Calculate the area enclosed between the survey line, irregular boundary and the first and last offsets, using the Trapezoidal and Simpson's rule.

2. The following perpendicular offsets were taken from a chain line to hedge

Chainage (m)	0	15	30	45	60	70	80	100	120	140

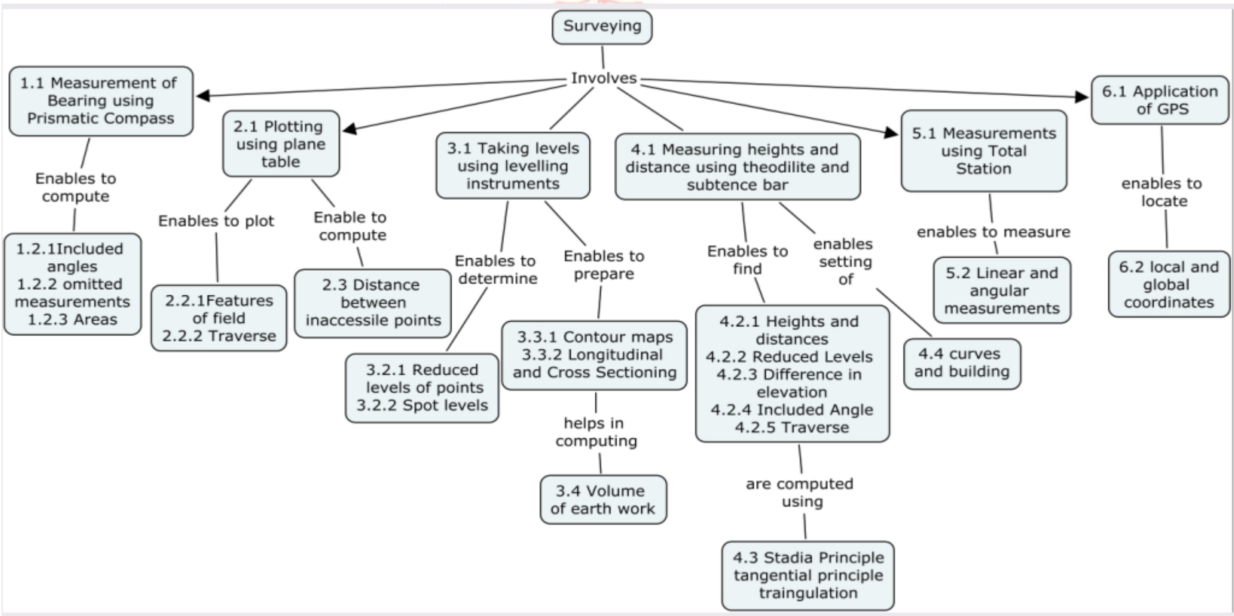
Offset (m)	7.60	8.50	10.7	12.8	10.6	9.5	8.3	7.9	6.4	4.4

Calculate the area between the survey line, the hedge and the end offsets by Simpson's rule.

Course Outcome 6 (CO6)

1. Explain the principle underlying EDM
2. State the significance of Total station in the modern methods of surveying
3. Discuss the application of GPS in surveying.
4. List the sources of errors in GPS and its limitations.

Concept Map



Syllabus

Introduction: Definition, classification of surveys, **Chain surveying:** Ranging and Chaining, obstacles in chaining, Errors in chain survey. **Compass surveying:** Prismatic compass, Magnetic declination, local attraction, Computation of compass traverse. **Plane table surveying:** Accessories, setting up, plane table techniques. **Levelling:** Types of levels, temporary adjustments of a level, methods of levelling, fly levelling, longitudinal sectioning and cross sectioning, contouring. **Areas and Volumes:** Calculation of areas and volumes by mid-ordinate, average ordinate, trapezoidal and Simpson's methods. **Theodolite Survey:** Measurement of horizontal and vertical angle, Stadia, tangential and trignometrical levelling. **Curves:** setting out of simple and compound curves. **Modern methods of surveying:** Electronic Distance Measurement (EDM), Global Positioning System (GPS), Total station and its application.

Text Book

1. **Punmia,B.C, Ashok K Jain and Arun K Jain, " Surveying" Vol. I&II, Laxmi Publication, 16th Edition, New Delhi, 2005.**

Reference Books

5. **Kanetkar,T.P, and Kulkarni,S.V,"Surveying and Levelling" Vol.I&II, United Book Corporation, 23rd Edition, Pune,1997.**
6. **Arora,K.R,"Surveying" Vol.I&II, Standard BookHouse Publishers & Distributors, New Delhi, 2008.**
7. **Venkatramaiah C, "Textbook of Surveying", University Press, 2nd Edition, Hyderabad, 2011.**

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	**Chain and Compass Surveying**	
1.1	Definition and classification of Survey	1
1.2	Ranging and chaining,	1
1.3	Obstacles in chaining and errors in chaining	1
1.4	Description of Prismatic compass, measurement of bearings	1
1.5	Local attraction and magnetic declination	1
1.6	Computation of compass traverse	2
2	**Plane table Surveying**	
2.1	Study of accessories and setting up of plane table	1
2.2	Radiation and intersection method	1
2.3	Three point and two point problem	3
3	**Levelling**	
3.1	Types of levels	1
3.2	Temporary adjustment of levels	1
3.3	Fly levelling	2
3.4	Longitudinal and cross sectioning	1
3.5	Drawing contours and uses of contour maps	2
4	**Areas and Volumes**	
4.1	Calculation of areas and volumes by mid-ordinate, average ordinate, trapezoidal and Simpson's methods	3
5	**Measurement using Theodolite**	
5.1	Components of transit theodolite and its adjustments	1
5.2	Measurement of horizontal and vertical angle	1
5.3	Measurement of distances and heights using stadia method	2
5.4	Measurement of distances and heights using tangential method	1
5.5	Measurement of distances and heights using trignometrical method	2
5.6	Curves and its classification	1
5.7	Setting out of simple circular curves	1
5.8	Setting out of compound curves	1
6	**Modern Methods of Surveying**	
6.1	Electronic Distance Measurements (EDM)	1
6.2	Applications of Global Positioning System (GPS)	1
6.3	Application of Total Station	2

Course Designers:

1. **Dr. K. Sudalaimani** **ksciv@tce.edu**
2. **Dr. T. Baskaran** **tbciv@tce.edu**

		Category	L	T	P	Credit
14CE240	**ENGINEERING GEOLOGY**	PC	3	0	0	3

Preamble

Engineering Geology is the application of the geologic sciences to engineering practise for the purpose of assuring that the geologic factors affecting the engineering works are recognised and adequately provided for. Engineering geologic studies may be performed during the planning and design. A civil engineer should be able to understand an engineering geologic report, and incorporate adequate measures into the design of engineering works he is concerned with.

Prerequisite

- Basic Sciences

Course Outcomes

On the successful completion of the course, students will be able to		Expected Attainment Level in %	Expected Proficiency Level in grade
CO1: Acquire the knowledge of the topographical formation, interior earth, gradational activities and weathering. And also the theory of plate tectonics which answers the reason for the occurrence of earthquake, landslides in an area.	Understand	60	B
CO2: Interpret minerals and rocks and assessment of its physical, mechanical and engineering properties.	Apply	60	B
CO3: Determine geological structures and its relevance on civil projects.	Apply	60	B
CO4: Analyze the surface and subsurface geological structures of the crust, soil and weathered thickness through geophysical exploration and report writing aspects with relevance to civil engineering projects.	Analyse	60	B
CO5: Assess the geological aspects of the site suitability with relevance to the design of structures civil and vice-versa.	Evaluate	60	B
CO6: Generate surface and subsurface geological structures of the earth's crust through geological cross section mapping	Analyse	60	B

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO5.	-	-	L	-	-	M	S	M	M	L	S	S	S	S
CO6.	-	-	-	-	-	M	M	L	L	L	L	M	S	-
CO3.	-	-	-	-	-	L	-	L	L	L	-	L	M	L
CO4	L	L	L	M	M	S	S	L	L	L	-	M	M	L
CO5.	M	M	M	S	M	S	S	S	S	L	S	S	S	S
CO6.	L	-	M	L	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	**40**	**20**	**10**	**10**
Understand	**30**	**20**	**30**	**30**
Apply	**30**	**20**	**20**	**20**
Analyse	**0**	**20**	**20**	**20**
Evaluate	**0**	**20**	**20**	**20**
Create	**0**	**0**	**0**	**0**

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. **Define continent.**
2. **Distinguish folded mountain and MOR.**
3. **List subdivisions of oceans.**
4. **Name the gradational forces.**
5. **Conclude topographical formation of the earth.**
6. **Describe chemical weathering and its impact on civil works.**
7. **Explain physical weathering.**
8. **Distinguish physical weathering from the chemical weathering products.**
9. **Generalise gradational activities and its impact on civil works.**
10. **Outline landslides and its types.**

Course Outcome 2 (CO2):

1. **Define earthquake.**
2. **Outline relation between convectional current and plate movements.**
3. **List types of subdivisions of earth's interior.**
4. **Name the ratings of earthquake..**
5. **Generalise the effect of earthquake.**
6. **Distinguish focus and epicentre.**
7. **Explain physical properties and behaviour of seismic waves within the earth's interior.**
8. **Summarise compositional layers of the earth.**
9. **Conclude the occurrence of earthquake with respect to plate tectonic theory**
10. **Illustrate internal structure of the earth.**

Course Outcome 2 (CO3):

1. **Define mineral.**
2. **Explain characteristics of sedimentary rocks in origin.**
3. **Conclude the influence of rock types in the selection of dam site.**
4. **Describe textures and structures of igneous rocks.**
5. **Explain textures and structures of sedimentary rocks.**
6. **Outline engineering properties of important igneous rocks.**
7. **Summarise physical properties of rocks.**
8. **Exhibit properties of the following minerals and rocks. a.Quartz b.calcite c.Kaoloinite d. Granite e.sandstone f.marble**
9. **Show the importance of rock properties in civil engineering works.**
10. **Illustrate the relationship between origin and properties of rocks.**

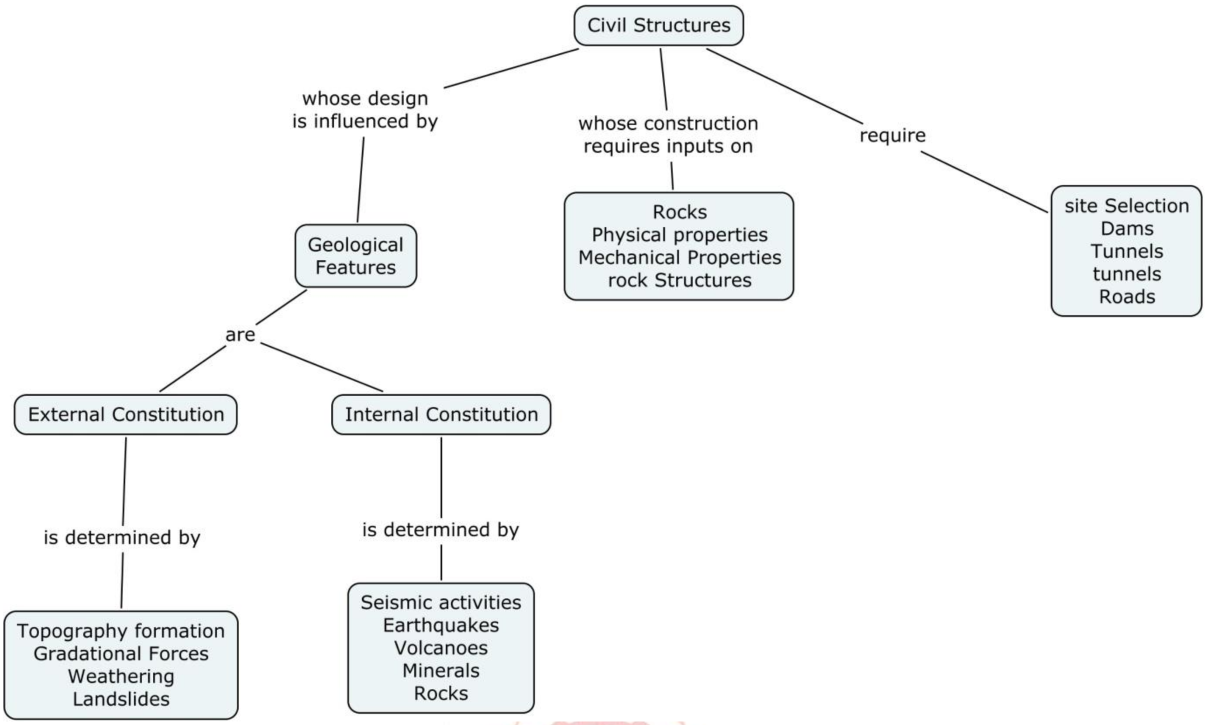
Course Outcome 3 (CO4)

1. **Analyse folds with respect to stress.**
2. **Classify faults with neat sketches.**
3. **Examine influence of rock structures over design of civil projects.**
4. **Distinguish folds and faults.**
5. **Appraise types of joints and its impact on civil project.**
6. **Outline the geophysical prospecting method for estimating thickness and depth of soil, weathered rock and depth to bed rock.**
7. **Illustrate how structures of rocks influence in the design of civil projects.**
8. **Relate concept of plate tectonics and rock structures.**
9. **Investigate the importance of rock structures in planning of civil engineering works.**
10. **Illustrate the importance of geological cross sections in the planning and design level.**

Course Outcome 5 (CO5)

1. **Appraise the importance of engineering geology in civil engineering design and planning works.**
2. **Assess various types of properties of rocks and its suitability in civil works.**
3. **Compare suitability of rock types for various civil structures.**
4. **Conclude the suitability of rock structures for various civil projects.**
5. **Criticise the role of engineering geologist in the civil projects.**
6. **Describe site suitability for construction of dams.**
7. **Explain site suitability for tunnel construction.**
8. **Summarise site suitability for road formation.**
9. **Determine site suitability for tall buildings.**
10. **Differentiate suitable and unsuitable site with respect to rock types and its structures.**

Concept Map



Syllabus

General Geology: Topographical formation-continents and oceans, Gradational forces - Weathering, and Landslides; **Seismology**: Seismic waves - Types and its characteristics, internal Structure of the Earth, Plate Tectonics - Earthquakes; **Minerals and Rocks** -Types of rocks and their textures and structures, Physical and Engineering Properties of Rocks; **Structural Geology:** Classification of Folds, Faults and Joints and its relevance on civil engineering structures; **Engineering Geology:** Geological and Geophysical investigation for site selection of Dams, Tunnels, Roads and Bridges.

Text Book

1. **Parbin Singh: Engineering and General Geology, Taylor & Francis, 2009.**

Reference Books

1. F.G. Bell (2007) Engineering Geology, Elsevier, 2nd ed.
2. F.G.H. Blyth & M.H. deFreitas (2001) A Geology for Engineers, Elsevier, 7th ed.
3. Structural Geology, 2010. Fossen H. Cambridge University Press, Cambridge.
4. Gonzalez de Vallejo, L.I. and Ferrer, M., 2011, Geological Engineering, CRC Press/Balkema, 678 pp.
5. Legget, R.F. and P.F. Karrow, 1983, Handbook of Geology in Civil Engineering, McGraw Hill, 1340 pp.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	GENERAL GEOLOGY	
1.1	**Introduction and importance of geology in civil engineering**	**1**
1.2	**Topgraphical formation – continents**	**1**
1.3	**Topographical formation – oceans**	**1**

Module No.	Topic	No. of Lectures
1.4	**Gradational forces- definition and its activities**	**1**
1.5	**Weathering-definition and its types**	**1**
1.6	**Weathering-products and its thickness and depth estimation**	**1**
1.7	**Landslides-definition and classification**	**1**
1.8	**Landslides-prediction and prevention techniques**	**1**
2	Seismology	
2.1	**Seismic waves definition, types and its characteristics**	**1**
2.2	**Interior of the earth – physical, chemical and its properties, and behaviour of seismic waves**	**2**
2.3	**Plate Tectonics theory – Origin and concept of theory, definition of plates, types, movement and its characteristics**	**1**
2.4	**Convectional current -plate movement, earthquake, types and its classification, terminologies, ratings of earthquake**	**2**
3	Minerals and Rocks	
3.1	**Minerals – definition, physical properties description**	**1**
3.2	**Minerals - Important minerals physical properties**	**2**
3.3	**Rocks – origin, types**	**1**
3.4	**Rocks – Physical, Mechanical and engineering properties**	**2**
3.5	**Rocks – important igneous rocks physical, mechanical and engineering properties**	**1**
3.6	**Rocks – important sedimentary rocks physical, mechanical and engineering properties**	**1**
3.7	**Rocks – important metamorphic rocks physical, mechanical and engineering properties**	**1**
3.8	**Rocks – Igneous textures and structures**	**1**
3.9	**Rocks – sedimentary textures and structures**	**1**
3.10	**Rocks – metamorphic textures and structures**	**1**
4	Structures of rocks	
4.1	**Folds – types and its relevance to planning and in civil works**	**1**
4.2	**Faults – types and its relevance to planning and in civil works**	**1**
4.3	**Joints - types and its relevance to planning and in civil works**	**1**
4.4	**Geological structure – geological map interpretation and analysis (cross section).**	**2**
4.5	**Geophysical study – estimation of thickness and depth of soil and weathered rock and depth to bed rock.**	**1**
5	Engineering Geology	
5.1	**Geological investigation on site analysis for construction of dams**	**1**
5.2	**Geological investigation on site analysis for construction of tunnels**	**1**
5.3	**Geological investigation on site analysis for construction of tall buildings and bridges**	**1**
5.4	**Geological investigation on site analysis for construction of roads**	**1**
	Total Hours	36

Course Designers:

1. S.Palanivel spciv@tce.edu
2. Mr.S.Subramanian ssciv@tce.edu

14CE250	ENVIRONMENTAL SCIENCE	Category	L	T	P	Credit
		BS	3	0	0	3

Preamble

The objective of this course is to make the students to understand the basic concepts of environment, ecology and scientific concepts of the current environmental issues. The course also emphasizes the importance of conserving and protecting the environment for sustainable development

Course Outcomes

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

ith Programme Outcomes

		Expected attainment Level %	Expected Proficiency (grade)
CO1. Explain the nature of various eco systems, their structure, composition, function, inter-dependency and values	Understand	80	A
CO2. Enunciate the values of bio-diversity, threats and suggest appropriate strategies for its conservation	Understand	80	A
CO3. Identify sources of environmental pollution and assess its implications	Apply	80	A
CO4. Implement strategies in achieving sustainable development and disaster management	Apply	80	A
CO5. Demonstrate various ethical principles, legal acts and traditional value systems in the conservation of environment	Apply	80	A

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	-	-	-	-	-	M	-	-	-	-	-	L	-
CO2	L	-	-	-	-	-	M	-	-	-	-	-	-	-
CO3	S	L	-	-	-	-	S	-	-	-	-	-	-	-
CO4	S	L	-	-	-	-	S	-	-	-	-	-	-	-
CO5	S	L	-	-	-	-	S	-	-	-	-	-	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	**20**	**20**	**20**	**20**
Understand	**60**	**60**	**40**	**40**
Apply	**20**	**20**	**40**	**40**
Analyze	**--**	**--**	**--**	**--**
Evaluate	**--**	**--**	**--**	**--**
Create	**--**	**--**	**--**	**--**

Course Level Assessment Questions

Course Outcome 1 (CO1):

11. **Explain biotic and abiotic components of an ecosystem**
12. **Discuss any one energy flow model of an ecosystem**
13. **Describe various types of ecological pyramids**
14. **Sketch the food web and food chain in a forest environment**
15. **Report on the various stages of ecological succession.**

Course Outcome 2 (CO2):

16. **Discuss the various values of bio-diversity and its importance**
17. **List a few hot spots in India**
18. **Demonstrate the In-situ and Ex-situ conservation of bio-diversity**
19. **India is a mega bio-diversity region. Discuss**

Course Outcome 3 (CO3):

20. **Apply a pilot model to combat deforestation**
21. **Review the ecological and commercial uses of forest resources**
22. **Write the significance surface water on the ground water resources**
23. **Summarize the major consequences of over exploitation of natural resources**

Course Outcome 4 (CO4):

24. **Identify the sources of air, water and soil pollution through various case studies**
25. **Name a few primary and secondary air pollutants**
26. **Demonstrate the effect of green house gases and acid rain**
27. **Summarize various precaution methods to be followed during earth quake, tsunami and flood**

Course Outcome 5 (CO5):

1. Define “Tsunami”
2. Explain the major causes for flood
3. How do you practice at the time of Tsunami and Earth quake

Course Outcome 6 (CO6):

Execute the concept of 3R principles for the prevention of environmental pollution

1. **Put into practice a green building for energy saving structure**
2. **Specify national and international strategies to control pollution**

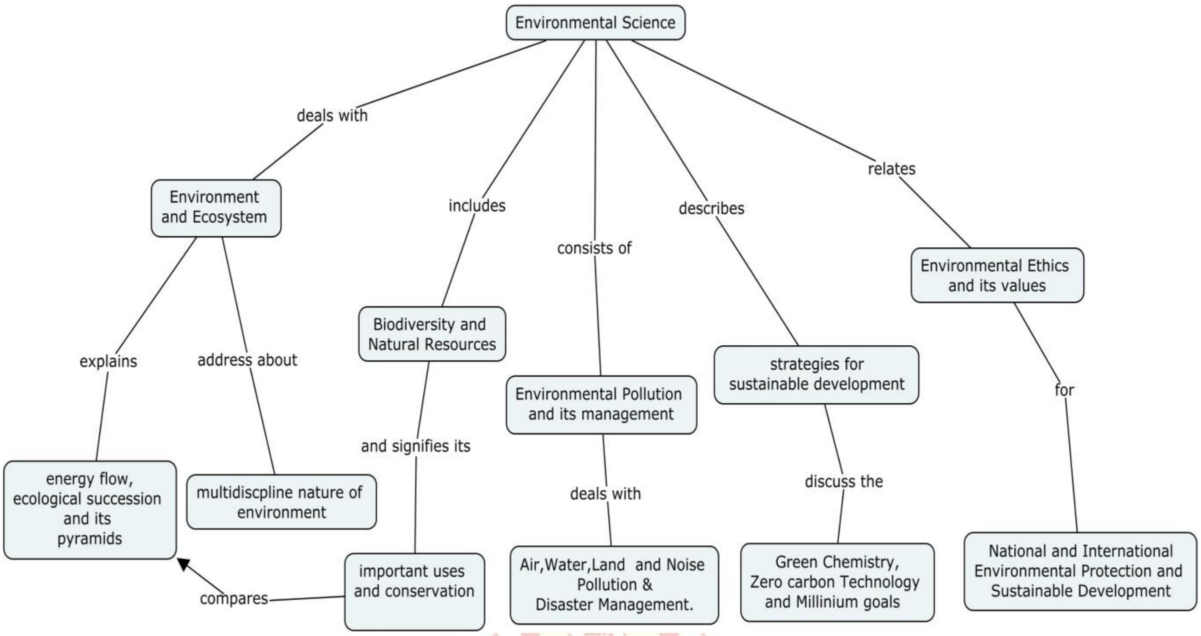
List a few renewable energy sources for sustainable development

3. Describe the advantages of hydrogen economy over carbon economy in the environmental aspects

Course Outcome 7 (CO7):

28. **Appraise the role of individual responsibility and ethics on the preservation of environment**
29. **Organize the various environmental acts to control pollution**
30. **Report the significance of water pollution act 1974**
31. **Compare the traditional values with a modern lifestyle and its impact on the environmental crises**

Concept Map



Syllabus

Environment and Ecosystem - Multidisciplinary nature of environment -Ecosystem- Types of Ecosystem-Energy flow in ecosystem-Ecological succession-pyramids - Loss of ecosystem -Case studies. **Biodiversity and Natural resources–**Biodiversity-types, values and threats -Bio-geographical classification, Hot spots of biodiversity-Endangered and endemic species- conservation of bio-diversity. Natural resources-types-over exploitation, effects and control. Role of individual in conservation of natural resources - Case studies. **Environmental pollution and control** - Environmental pollution – types, causes, effects and control measures – Radiation hazards - protection and safety-Climate change – causes and its effect on environment– acid rain - ozone layer depletion-remedial measures. Disaster management - case studies. **Strategies for Sustainable Environment** - Green Chemistry –Zero carbon technology, Hydrogen economy - Green Building concepts –Millennium Development Goals. **Environmental Ethics and Values** Social issues and the environment, Need for public awareness, Environmental Ethics, Traditional value systems in India, Legal provisions-Environmental acts and issues in enforcement, Value education-Safety, health and environment, National and International Organizations in Environment, Objectives and functions-Case studies

Text Book

8. Kausik and Kausik, ‘Environmental Science and Engineering’, 3rd Edition, New Age International Publishers, New Delhi, 2008

Reference Books

9. Wright and Nebel, ‘Environmental Science towards a sustainable’, future, Prentice Hall of India Ltd,2000.
10. S.K. Garg and Garg, ‘Ecological and Environmental studies’, Khanna Publishers, Delhi,2006
11. Gillbert M. Masters, ‘Introduction to Environmental Engineering and Science’, Second Edition, pearson education publication , Delhi,2004.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	Environment and Ecosystem	
1.1	**Multidisciplinary nature of environment**	**1**
1.2	**Ecosystem-Types of Ecosystem (forest, grass land, desert, aquatic ecosystem)**	**1**
1.3	**Energy flow in ecosystem, Ecological succession-pyramids**	**2**
1.4	**Loss of ecosystem - Case studies**	**2**
2.0	Biodiversity and Natural resources	
2.1	**Biodiversity-types, values and threats**	**2**
2.2	**Bio-geographical classification and Hot spots of biodiversity**	**1**
2.3	**Endangered and endemic species – Insitu , Ex-situ-conservation of bio-diversity**	**2**
2.4	**Natural resources- types-Forest, water, land, food, energy**	**2**
2.5	**Over exploitation of natural resources - effects and control**	**2**
2.6	**Role of individual in the conservation of natural resources-Case studies.**	**1**
3.0	Environmental Pollution and Control	
3.1	**Environmental pollution – Air, water, soil and noise pollution causes, effects and control measures**	**3**
3.2	**Radiation hazards - protection and safety**	**1**
3.3	**Climate change – causes and its effect on environment– acid rain - ozone layer depletion-Remedial measures**	**2**
3.4	**Disaster management (earthquake, tsunami and flood) - case studies**	**2**
4.0	Strategies for Sustainable Environment	
4.1	**Green Chemistry–Zero carbon technology, Hydrogen economy**	**2**
4.2	**Green Building concepts**	**1**
4.3	**Millennium Development Goals**	**1**
5.0	Environmental Ethics and Values	
5.1	**Social issues and environment- need for public awareness**	**1**
5.2	**Environmental Ethics, Traditional value systems in India**	**2**
5.3	**Legal provisions- Environmental acts - Air, water, soil, forest and wildlife acts - issues in enforcement**	**2**
5.4	**Value education-Safety, health and environment**	**1**
5.5	**National and International Environmental Organizations - Objectives and functions- Case studies**	**2**
	Total hours	**36**

Course Designers:

1.	Dr.M.Kottaisamy	mmksami@tce.edu
2.	Dr.T.Vel Rajan	tvciv@tce.edu
3	Dr.S.Chandran	schandran@tce.edu

14CE270	BUILDING MATERIALS AND TECHNOLOGY	Category	L	T	P	Credit
		PC	2	0	2	3

Preamble

This theory cum practical course is designed to give an exposure on the theoretical concepts of various materials and techniques in construction.

It also gives an overview on planning aspects of residential building components, lighting and ventilation as per NBC provisions.

This course also aims to apply the theoretical knowledge to practical problems.

Course Outcomes

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

COs for Theory part:

On the successful completion of the course, students will be able to		Expected Attainment Level in %	Expected Proficiency Level in grade
CO1- Identify and classify buildings based on National Building Codal (NBC) provisions	Understand	85	S
CO2 - Orient and plan, components of residential building such as: open spaces, habitable rooms, kitchen, bath and water closet as per NBC provisions with lighting and ventilation requirements	Apply	85	S
CO3 - Identify various construction materials like stones, bricks, timber, cement, lime, concrete, steel, plastics, flyash, GGBS, Silica fume, PCC and RCC. Explain their properties with specific utilization in the construction industry.	Understand	85	S
CO4 - Demonstrate knowledge and understanding of the principles and concepts relevant to construction techniques in super structure such as: masonry work, arches, lintels, staircase, DPC, floor– ground floors, upper floors, flooring roof – flat and pitched roofs, weathering courses- types, pointing, finishing, scaffolding, shuttering, shoring, underpinning. Able to apply appropriate technique for given situations	Apply	85	S

COs for Practical part

		Expected Attainment Level in %	Expected Proficiency Level in grade
CO5 Apply NBC provisions and plan components of residential buildings for the given plot size with suitable lighting and ventilation provisions	**Analyse**	**85**	**S**
CO6 Conduct tests on building materials like bricks, stones, timbers, steel and cement.	**Apply**	**85**	**S**
CO7 Use appropriate tools and equipment for testing building material such as: bricks, stones, steel rods, timber	**Apply**	**85**	**S**
CO8 Demonstrate different types bonds in brick masonry work	**Apply**	**85**	**S**
CO9 Identify and classify the different types of staircases in the campus discussing its details	**Apply**	**85**	**S**

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO7.						L	L			L		L
CO8.	M	S	M			L	L			L		L
CO3					M	L	M		L	L	L	L
CO4					M	L	M		L	L	L	L
CO5	M	S	M			M	M			L		L
CO6						M						
CO7						M						
CO8					M	M	M					
CO9						M						

S- Strong; M-Medium; L-Low

Assessment Pattern: Theory Part:

<table>
<tr><th rowspan="2">Bloom's Category</th><th colspan="2">Continuous Assessment Tests</th><th>Test 3</th><th rowspan="2">Terminal Examination (Theory part only for 100 marks)</th></tr>
<tr><th>1</th><th>2</th><th rowspan="7">Practical Examination (30 marks)</th></tr>
<tr><td>Remember</td><td>20</td><td>10</td><td>20</td></tr>
<tr><td>Understand</td><td>40</td><td>30</td><td>40</td></tr>
<tr><td>Apply</td><td>40</td><td>60</td><td>40</td></tr>
<tr><td>Analyse</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Evaluate</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Create</td><td>0</td><td>0</td><td>0</td></tr>
</table>

Practical Part: Continuous Assessment mode

Course Level Assessment Questions (Theory Part)

Course Outcome 1 (CO1)**:**

32. **List the classification of building as per NBC**
33. **Sivakasi Crackers factory is planning to store its finished goods. Suggest a suitable building giving its salient features.**
34. **Differentiate institutional and commercial buildings.**

Course Outcome 2 (CO2)**:**

1. **Define the term orientation of buildings**
2. **Write the meaning of habitable room**
3. **How should a residential building of 300sq.m with kitchen, bedroom, living room and bath & water closet be positioned to derive max benefit from natural agencies?**

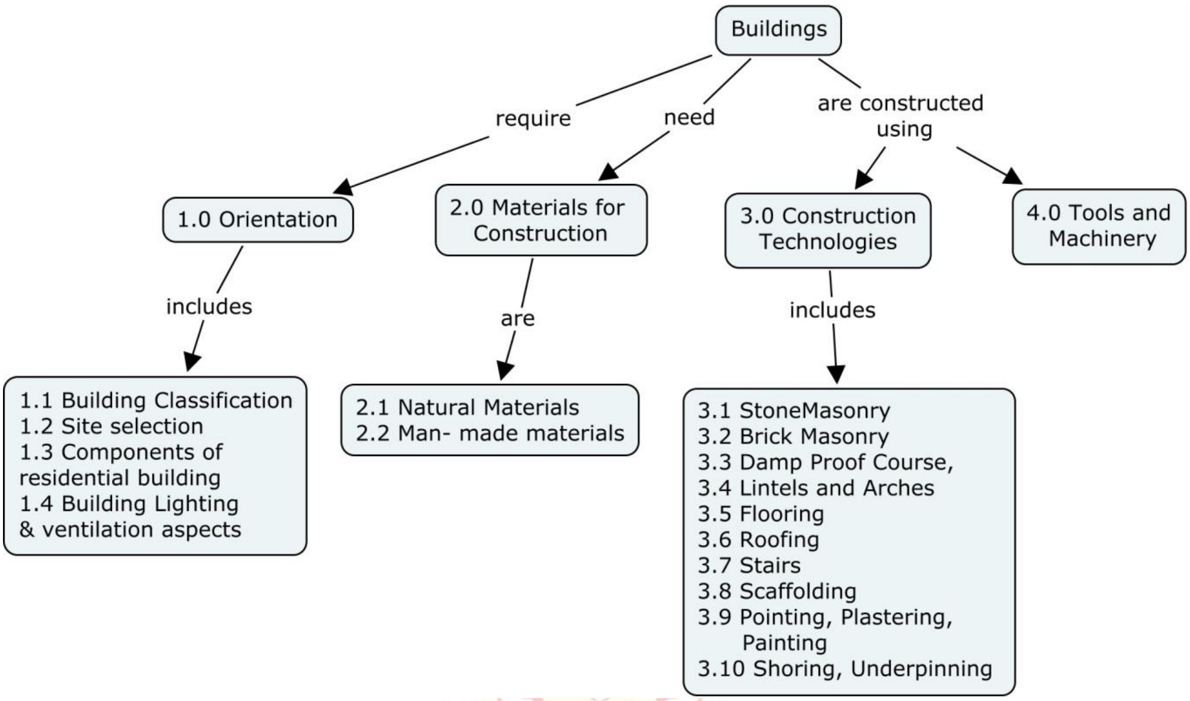
Course Outcome 3 (CO3):

1. **As a civil engineer how would you recommend a stone for building construction**
2. **Write the purpose of addition gypsum to cement.**
3. **How is proportioning of ingredients done for manufacturing concrete?**

Course Outcome 4 (CO4):

1. **Mention the use of lap in brick masonry**
2. **Write the purpose of lacing course in stone masonry**
3. **Identify why a double scaffolding is preferred than single scaffolding for stone masonry construction? Give suitable reasons.**

Concept Map



Syllabus

Orientation of Buildings**: Classification of buildings as per NBC. Site selection and its influencing factors, National Building Codal provisions for components of residential buildings: Open spaces, Living room, Bed room, Kitchen, Bathroom and Water closet, National Building Codal provisions for lighting and ventilation aspects in buildings.** Materials for Construction**: Natural materials- stones, aggregates, timber, lime. Man- made materials: bricks, cement, steel, concrete, plastics, flyash, GGBS, Silica fume, PCC and RCC.** Technologies of Construction**: Masonry- Stone and Brick, Damp Proof Course, Lintels and Arches, Flooring, Roofing, Stairs, Scaffolding, Pointing, Plastering, Painting, Special Construction Techniques: Shoring, Underpinning.** Construction Tools and Machinery**: Tools: plumb bob, spirit level, level tube, rammer, spade, shovels, straight edge, mortar pans, sieves, trolley, vibrators, bulldozers, draglines, cableways, belt conveyors Machinery: batching plants, transit mixers and vibratory trucks for ready mixed concrete, pumps, air compressors, hoists and cranes, Choice of construction equipments for different types of works.**

References:

Text Book

12. Punmia B.C., Ashok Kumar Jain, Arun Kumar Jain, “Building Construction”, Laxmi Publications Pvt. Ltd., 2012

Reference Books

1. Rangwala S.C., “Engineering Materials” Charotar Publishing House, Anand, India, 2014

2. Deodhar S.V., “Construction Equipment and Job Planning”, Khanna Publishers, New Delhi, 2014
3. Surendra Singh, “Building Materials”, Vikas Publishing Company, New Delhi, 1996
4. Bindra and Arora, “Building Materials and Construction”, Dhanpat Rai & Sons, New Delhi, 1994
5. National Building Code of India, Bureau of Indian Standards, 2005
6. Peurifoy. R. L, “Construction Planning, Equipment and Methods”, McGraw Hill Co., New York, 2010

Course Contents and Lecture Schedule (Theory Part)

Module No.	Topic	No. of Lectures
1.0	**Orientation Buildings**	
1.1	Classification of Buildings as per NBC	1
1.2	Site selection and its influencing factors	
1.3	National Building Codal provisions for components of residential buildings: Open spaces, Living room, Bed room, Kitchen, Bathroom and Water closet	2
1.4	National Building Codal provisions for lighting and ventilation aspects in buildings	1
2.0	**Materials for Construction**	
2.1	Natural materials - Stones, timber, lime, aggregates – properties and uses	2
2.2	Man made materials- Bricks, cement, concrete, steel, plastics, flyash, GGBS, silica fume, PCC and RCC	2
3.0	**Technologies of Construction**	
3.1	Stone Masonry	2
3.2	Brick Masonry	2
3.3	Damp Proof Course	2
3.4	Lintels and Arches	
3.5	Flooring	2
3.6	Roofing	2
3.7	Stairs	2
3.8	Scaffolding	1
3.9	Pointing, Plastering, Painting	1
3.10	Special Construction Techniques	1

4.0	**Construction Tools**: plumb bob, spirit level, level tube, rammer, spade, shovels, straight edge, mortar pans, sieves, trolley **Machinery**: batching plants, transit mixers and vibratory trucks for ready mixed concrete, pumps, air compressors, hoists and cranes	1
	Total Hours	**24**

List of Exercises for Practical Part

Module No.	Exercise No.	No. of Lectures
1.	Apply NBC provisions and plan components of residential buildings for the given plot size	2
2.	Apply suitable lighting and ventilation provisions of NBC for components of residential buildings for the given plot size	2
3.	Conduct tests on building materials - bricks	2
4.	Conduct tests on building materials - stones	2
5.	Conduct tests on building materials - timber	2
6.	Conduct tests on building materials - steel	2
7.	Conduct tests on building materials - cement	2
8.	Demonstrate different types bonds in brick masonry work	2
9.	Demonstrate different types bonds in brick masonry work	2
10.	Identify and classify the different types of staircases in the campus discussing their details	2
11.	Identify and classify the different types of masonry in the campus discussing their details	2
12.	Identify and classify the different types of roofs, floors, finishes provided in the campus discussing its features	2
	Total Hours	**24**

Course Designers:

1.	Dr. G. Chitra	gcciv@tce.edu
2.	Dr. D. Brindha	dbciv@tce.edu
3.	Ms. D. Srividya	dsciv@tce.edu

14CE280	SURVEY LAB I	Category	L	T	P	Credit
		PC	0	0	2	1

Preamble

The theory part of Surveying can be experimented in Survey lab I. This includes the experiments on chains, compass, plane table and levels.

Course Outcomes

On the successful completion of the course, students will be able to		Expected Attainment Level in %	Expected Proficiency Level in grade
(CO1): Select the appropriate surveying tools in the field	Apply	95	S
(CO2): Measure, book and plot the details of the given terrain.	Apply	95	S
(CO3): Perform the required adjustments as well as compensate the errors in the field measurements.	Apply	95	S
(CO4): Locate the field position on the plan or vice versa	Apply	95	S
(CO5): Locate the elevation of given points with respect to a given datum.	Apply	95	S
(CO6): Plot LS and CS of the given terrain	Apply	95	S

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1.	M	L	L	L	-	S	-	-	-	L	-	-	L	L
CO2.	S	L	L	S	-	S	-	S	-	L	-	-	M	L
CO3.	S	S	S	S	-	-	-	S	-	L	-	-	M	L
CO4.	S	S	S	S	-	S	-	-	-	L	-	-	M	L
CO5.	S	S	S	S	-	S	-	-	-	L	-	-	M	L
CO6.	S	S	S	S	M	S	-	-	-	S	-	-	M	L

S- Strong; M-Medium; L-Low

List of Experiments:

1. Chain survey – Ranging and Chaining

2. Prismatic Compass – Open traverse
3. Prismatic Compass – Closed traverse
4. Plan table surveying – Radiation and Intersection method
5. Three point problem – Trial and Error method
6. Three point problem – Tracing sheet method
7. Three point problem – Bessel's method
8. Three point problem – Right angle method
9. Two point problem
10. Fly levelling
11. Check levelling
12. Plotting of Longitudinal sectioning and Cross sectioning

Course Designers:

1. Dr. K. Sudalaimani ksciv@tce.edu
2. Dr. T. Baskaran tbciv@tce.edu

14CE290	**WORK SHOP**	Category	L	T	P	Credit
		PC	0	0	2	1

(Common to B.E. Mechanical Engineering and B.E. Mechatronics Engineering)

Preamble

Workshop is a hands-on training practice to Mechanical and Civil engineering students. It deals with fitting, carpentry, sheet metal and related exercises. Also, it will induce the habit of selecting right tools, planning the job and its execution.

Prerequisite

NIL

Course Outcomes

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

ith Programme Outcomes

		Expected Attainment Level %	Expected Proficiency level
CO1. Construct the different laminas of regular shapes.	Apply	100	A
CO2. Prepare the different types of fitting using MS plate.	Apply	100	A
CO3. Create simple sheet metal components	Apply	100	A
CO4. Prepare the different types of joints using wooden material.	Apply	100	A

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12	PSO1	PSO2
CO 1	M	M	L	L	L	-	-	-	M	-	-	-	L	-
CO 2	M	L	-	-	-	-	-	-	-	-	-	-	L	-
CO 3	L	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	M	L	L	L	L	-	-	-	L	-	-	-	L	-

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO7.	S	L	L	L	L	L	L	L	L	L	L	L
CO8.	S	L	S	L	L	L	L	L	L	L	L	L
CO9.	S	S	S	L	L	L	L	L	L	L	L	L
CO10.	S	L	S	L	L	L	L	L	L	L	L	L

S- Strong; M-Medium; L-Low

Syllabus

I Card Board Exercises **(4 Hours/6 periods)**

1. Construction of cube, Triangular, square, Pentagonal and Hexagonal Prisms (Any one solid)

2. Construction of Triangular, square, Pentagonal and Hexagonal Pyramids (Any one solid)

II Fitting (6 Hours/9 periods)

Preparation of Square, V, L, Gauge, Taper, Radius and Dove tail Fitting (Any one Fitting Exercise)

III Sheet Metal Exercises (6 Hours/9 periods)

Preparation of Liter Cone, Dust pan (Straight, Taper) and Tray (Straight, Taper) - (Any one sheet metal Exercise)

IV Carpentry (6 Hours/9 periods)

Preparation of Door frame using Mortise & Tenon joint and Mitered Mortise & Tenon joint.

V Demo on Plumbing (2 Hours/3 periods)

Assessment Pattern

All the exercises are evaluated on continuous assessment basis based on the fit/finish of the component, measurement and record. Students are given with additional attempt on each trade for their better performance (within the specified time of each trade). The distribution of marks in each trade is as follows:

Trade	Fit/Finish	Record	Total (Marks)
Card Board Exercises	15	5	20
Fitting	15	5	20
Sheet Metal	25	5	30
Carpentry	25	5	30

- **Students are evaluated based on continuous assessment only and pass mark should be minimum 50. Also no terminal examination for this course.**
- **If he/she got less than 50 marks, he/she has to undergo the terminal examination for 100 marks in subsequent semester as supplementary examination.**

Course Designers:

1. C. Paramasivam cpmech@tce.edu
2. ML. Mahadevan mlmmech@tce.edu

14CE310	FOURIER SERIES AND PARTIAL DIFFERENTIAL EQUATIONS	Category	L	T	P	Credit
			2	1	0	3

Preamble

An engineering student needs to have some basic mathematical tools and techniques. This emphasizes the development of rigorous logical thinking and analytical skills of the student and appraises him the complete procedure for solving different kinds of problems that occur in engineering. Based on this the course aims at giving adequate exposure in the theory and applications of Fourier series, Fourier Transforms, PDE's and BVP.

Prerequisite

Knowledge on Integration and basic differentiation

Course Outcomes

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

Course Outcomes	Bloom's level	Expected attainment level (%)	Expected Proficiency (%)
CO1 : Express the periodic functions arising in the study of engineering problems as Fourier series of Sines and Cosines	Apply	70	B
CO2: Find the Fourier series for discrete data using Harmonic analysis.	Apply	60	B
CO3 Solve some of the well-known integral transforms (like Fourier, Fourier Sine and Cosine) and properties	Apply	70	B
CO4: Solve Partial Differential Equations, linear, nonlinear, homogeneous and non-homogeneous, by various methods	understand	65	B
CO5: Formulate simple Engineering problems as Partial Differential Equations and state the boundary conditions.	Understand	60	C
CO6: Solve the standard Partial Differential Equations arising in engineering problems like Wave equation, Heat flow equation (one dimensional Cartesian coordinates) by Fourier series.	Apply	70	B

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
													S	S
CO1	S	S	S										S	S
CO2	M	M												
CO3.	S	M	M											
CO4.	S	S											S	M
CO5.	S	M	S										M	
CO6.	M	M											S	S
CO7	S	S	S										S	S

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	0
Understand	30	30	30	30
Apply	60	60	60	70
Analyze	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

CO7: Solve the standard Partial Differential Equations arising in engineering Problems like heat flow equation (two dimensional Cartesian and polar coordinates) by Fourier series.	Apply	65	B

Mapping with Programme Outcomes and Programme Specific Outcomes

Assessment Pattern

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define periodic function with an example.
2. Prove that $x^2 = \frac{\pi^2}{3} + \sum_{n=1}^{\infty}(-1)^n \frac{\cos nu}{n^2} - \pi < x < \pi$.
3. Find Fourier cosine series of $f(x) = \begin{cases} x^2, & 0 < x < 1 \\ 2 - x, & 1 < x < 2 \end{cases}$.

Course Outcome 2 (CO2):

1. Define harmonic analysis in Fourier series

2. If a function f (x) is given by the following tables of values find the harmonic analysis of the function up to third harmonic.

x	0	1	2	3	4	5
y	9	18	24	28	26	20

3. Compute the harmonic analysis for the following table values up to second harmonic

x	0	$\Pi/6$	$\Pi/3$	$\Pi/2$	$2\Pi/3$	$5\Pi/6$
y	10	12	15	20	17	11

Course Outcome 3(CO3):

1. State Shifting Property in Fourier transforms.
2. Find FST of e^{-ax}, a > 0, Find $F_S\{xe^{-ax}\}$ and $F_S\left\{\frac{e^{-ax}}{x}\right\}$ and deduce the value of

$$\int_0^{\infty}\frac{\sin sx}{x}\,dx$$

3. Apply Parseval's identity, evaluate $\int_0^{\infty}\frac{dx}{(x^2+1)^2}=\frac{\pi}{4}$ (ii) $\int_0^{\infty}\left(\frac{1-\cos x}{x}\right)^2 dx$

(iii) $\int_0^{\infty}\frac{\sin^4 x}{x^2}\,dx$

Course Outcome 4(CO4):

1. Find the PDE by eliminating arbitrary functions from (i) $z=e^{ny}\phi(x-y)$

   (ii) $lx+my+nz=\phi(x^2+y^2+z^2)$.
2. Solve the following Partial Differential Equation

   (i) $z=px+qy+\sqrt{\alpha p^2+\beta q^2+\gamma}$ (ii) $z=px+qy+\sqrt[3]{pq}$.
3. Solve $(D^3+D^2D'-DD'^2)z=e^{2x+y}+\cos(x+y)$.

Course Outcome 5(CO5):

1. Find the temperature u (x, t) in a bar which is perfectly insulated laterally whose ends are kept at temperature 0^0 c and whose initial temperature in ($^\circ$C) is f (x) = x (10 – x). Given that its length is 10 cm consent cross section of area 1 cm ^{2}, density 10.6 gm / cm ^{3} thermal

conductivity 1. 04 cal / cm degree and specific heat 0. 0 56 cl /cm degree. Frame the boundary conditions for the given data.

2. A bar of length a is at 0 temperature. At t = 0 the end x = a is suddenly raised to temperature u_0 and the end x = 0 is insulated. Find the temperature at the any point x of the bar at any time t > 0 , assuming that the surface of the bar is insulated. Frame the boundary conditions for the given data.

3. An infinite string is initially at rest along the x – axis. It's one end which is at x = 0 is given a periodic transverse displacement $a_0 \sin \omega t$, t > 0 show that the displacement of any point of the string at any time is given by $y(x,t) = \begin{cases} a_0 \sin \omega(\frac{t-x}{c}), t > \frac{x}{c} \\ 0, t < \frac{x}{c} \end{cases}$ where c is the velocity. Frame the boundary conditions for the given data.

Course Outcome 6(CO6)

35. **A string is stretched and fastened to two points' *l'* apart .Motion is started by displacing the string into the form y=k(*l*x-x^2) from which it is released at time t=0 find the displacement of any point of the string at a distance x from one end at any time t.**

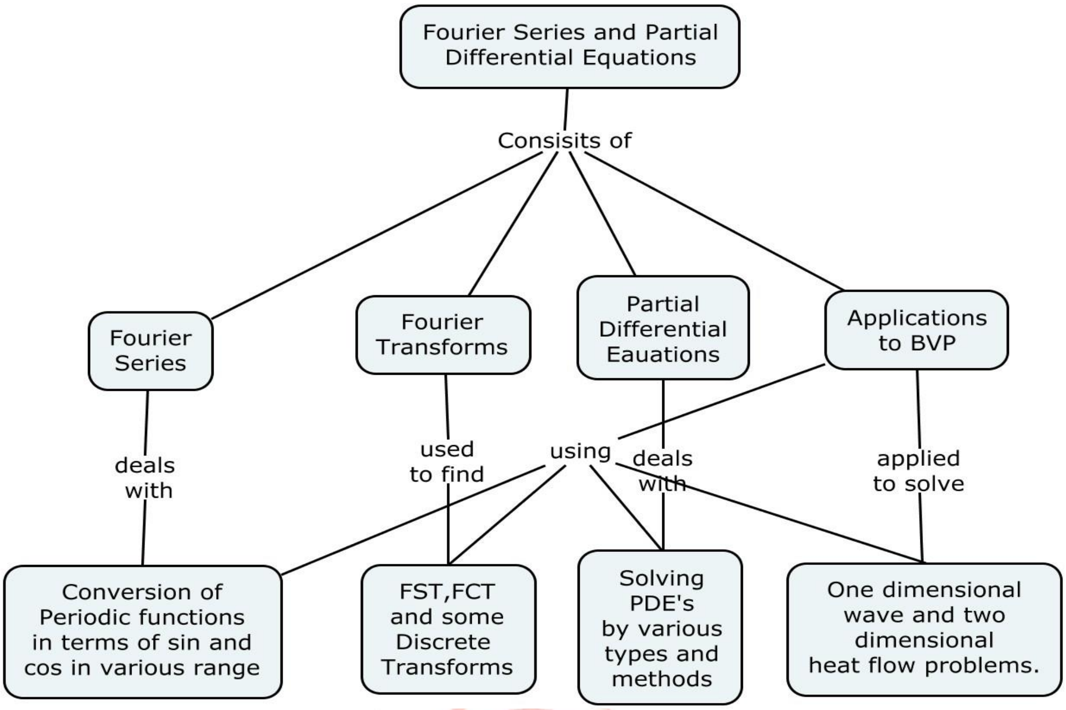
36. **A bar 10 cm long has originally a temperature of 0^0 c throughout its length. At time t = 0 second the temperature at the end x = 0 is raised to 20^0 c , while that at the end x = 10 is raised to 40^0 c . Determine the resulting temperature distribution in the bar.**

37. **A rod of length l has its ends A and B kept at 0^0c and 120^0c respectively until steady state condition prevail. If the temperature at B is reduced to 0^0c and kept so while that of A is maintained, find the temperature distribution of the rod.**

Course Outcome 7(CO7)

1. **A thin semi circular plate of radius a has its bounding diameter kept at temperature zero and its circumference at $f(\theta), 0 < \theta < \pi$. Find the steady state temperature distribution at any point of the plate. If f(θ) =k, find the temperature.**
2. **An infinitely long plane uniform plate is bounded by two parallel edges x > 0 and x= l and an end at right angles to them. The breadth of this edge y = 0 is l and is maintained at a temperature f(x). All the other three edges are at temperature 0^0c. Find the steady state temperature at any interior point of the plate**
3. **Find the steady state temperature in a circular plate of radius 'a' which has one half of its circumference at 0^0c and the half at k^0c.**

Concept Map



Syllabus

Fourier Series: Dirichlet's conditions, General Fourier Series, Half range Sine and Cosine series, Change of Interval, Harmonic Analysis, Complex form of Fourier Series. **Fourier Transformation:** Fourier Integral Theorem, Fourier Transform, Fourier Sine and Cosine Transforms, properties, Parseval's Identity, Discrete Fourier Transform, Discrete Time Fourier Transform. **Partial Differential Equations**: Formation, Solution of standard types of first order equations, Lagrange's linear equation, Linear partial differential equations of second and higher order with constant coefficient. **Boundary Value Problems**: Classification of Second Order linear partial differential equations, One-dimensional Wave equation, One dimensional heat equation, Solution by Fourier Series, Steady State Solution of two dimensional heat equation in Cartesian Co-ordinates, Laplace equation in Polar Co-ordinates, Solution by Fourier Series method.

Text Books

38. **B.S. Grewal: Higher Engineering Mathematics, 39th Edn. , Khanna Publishers, New Delhi, 2007.**
39. **Veerarajan .T, "Engineering Mathematics", 3rd Edition. , Tata McGraw Hill, New Delhi, 2004.**

Reference Books

1. **Kreyszig,E., "Advanced Engineering Mathematics", John wiley and sons,(Asia)Pte Ltd., Singapore.2006.**

2. **Kandasamy.P, Thilagavathy.K, Gunavathy.K , "Engineering Mathematics Vol. III", S.Chand & Company Ltd, New Delhi, 2008.**

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	**Fourier Series**	
1.1	Dirichlet's conditions, General Fourier Series	2
	Tutorial	1
1.2	Half range Sine and Cosine series	1
	Tutorial	1
1.3	Change of Interval	1
	Tutorial	1
1.4	Harmonic Analysis	1
	Tutorial	1
1.5	Complex form of Fourier Series	1
	Tutorial	1
2.	**Fourier Transformation**	
2.1	Fourier Integral Theorem, Fourier Transform	2
	Tutorial	1
2.2	Fourier Sine and Cosine Transforms	1
	Tutorial	2
2.3	Properties, Parseval's Identity	1
	Tutorial	1
2.4	Discrete Fourier Transform, Discrete time Fourier Transform	1
	Tutorial	1
3	**Partial Differential Equations**	
3.1	Formation	1
	Tutorial	1
3.2	Solution of standard types of first order equations	2

	Tutorial	1
3.3	Lagrange's linear equation	1
	Tutorial	1
3.4	Linear partial differential equations of second and higher order with constant coefficient	1
	Tutorial	1
4	**Boundary Value Problems**	
4.1	Classification of Second Order linear partial differential equations	1
	Tutorial	2
4.2	One-dimensional Wave equation, Solution by Fourier Series	2
	Tutorial	2
4.3	One dimensional heat equation, Solution by Fourier Series	2
	Tutorial	2
4.4	Steady State Solution of two dimensional heat equation in Cartesian Co-ordinates, Solution by Fourier Series	2
	Tutorial	2
4.5	Laplace equation in Polar Co-ordinates, Solution by Fourier Series	1
	Tutorial	2
	Total	**48**

.

Course Designers:

Prof. P. Subramanian psmat@tce.edu

Dr. M. Sivanandha Saraswathy Sivanandha@tce.edu

Dr. N. Chitra ncmat@tce.edu

		Category	L	T	P	Credit
14CE321	**MECHANICS OF SOLIDS**	PC	2	2	0	3

Preamble

This course offers the basic modules of mechanics of solids such as articulated structures, suspension cables and suspension bridges. This course aims at determination of axial and bending stresses, design of circular shafts, slope and deflection of beams, effect of moving loads and construction of influence lines.

Prerequisite

Fundamentals of Engineering Mathematics and physics.

Course Outcomes

	On the successful completion of the course, students will be able to		**Expected Attainment Level in%**	**Expected Proficiency Levelin grade**
CO1	Compute axial and bending stress.	Apply	70	A
CO2	Select sections for circular shafts	Apply	70	A
CO3	Determine slope and deflection of determinate beams	Apply	70	A
CO4	Calculate forces in member of a truss	Apply	70	A
CO5	Demonstrate the effect of moving loads and to construct influence line diagram for determinate beams	Apply	70	A
CO6	Analyse suspension cables, three hinged stiffening girders and three hinged arches	Apply	70	A

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	M	-	-	L	-	-	-	M	-	-	L	L
CO2	M	M	-	-	-	-	-	-	-	-	L	-	L	L
CO3	S	S	-	-	-	-	-	-	-	-	-	-	L	L
CO4	S	S	-	M	-	M	-	-	-	-	-	-	M	M
CO5	S	S	-	-	-	L	M	-	M	S	-	-	M	M
CO6	S	S	M	-	-	L	M	-	-	-	-	-	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination**
	1	**2**	**3**	

Remember	10	10	10	10
Understand	10	10	10	10
Apply	80	80	80	80
Analyze	--	--	--	--
Evaluate	--	--	--	--
Create	--	--	--	--

Course Level Assessment Question

Course Outcome 1 (CO1):

40. **A rectangular column of size 250mm x 350mm is subjected to a load of 500kN at 120mm from the shorter edge and 45mm from the longer edge. Determine the stress distribution. What is the maximum load the column can sustain if the permissible stresses are +3.5 MPa and -35.0 MPa.**
41. **A 6m long truss member comprises two ISA 100x100x10 section placed back to back. Determine its maximum load carrying capacity assuming E = 190GPa and σy = 360MPa.**
42. **A mild steel square tube of external dimensions 100mm and 5mm wall thickness is 3.6m long. Determine the maximum permissible eccentricity of load in the axial direction if the load is 80 percent of the Euler's load. Assume E = 200GPa and σy = 250MPa when**
    i.) Both ends are hinged
    ii.) One end is fixed and other end is free

1. How will you obtain deflection of a close coiled helical spring?

Course Outcome 2 (CO2):

2. Find the power transmitted by a shaft of 60mm diameter at 3Hz. If the maximum permissible shear stress is 70N/mm^2.

3. A solid shaft has to transmit 337.5kW at 100rpm. If the shear stress is not to exceed 65N/mm^2 and the internal diameter is 0.6 of the external diameter, find the external and internal diameters assuming that the maximum torque is 1.3times the mean.

Course Outcome 3 (CO3):

43. **Develop the governing differential equation of beams.**
44. **A cantilever beam of span 6m is subjected to two point loads of 10kN and 15kN at 6m and 4m from the fixed end. Obtain the slope and deflection under the load points.**
45. **A simply supported beam of span 4.5m is subjected to a uniformly distributed load of 12kN/m over the left half of the span. Obtain the maximum deflection using Macaulay's method.**

Course Outcome 4 (CO4):

46. **Determine the force in the members of the truss shown in the following Figure**

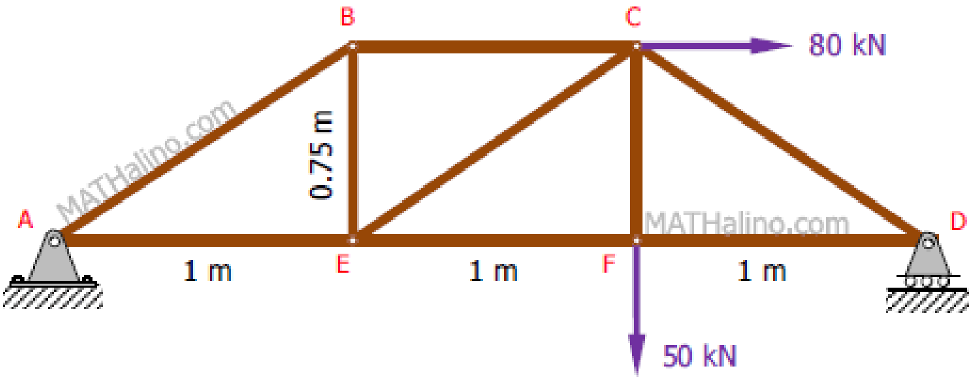


Figure T-01

47. **Determine the force in the members of the cantilever truss shown in Fig.**

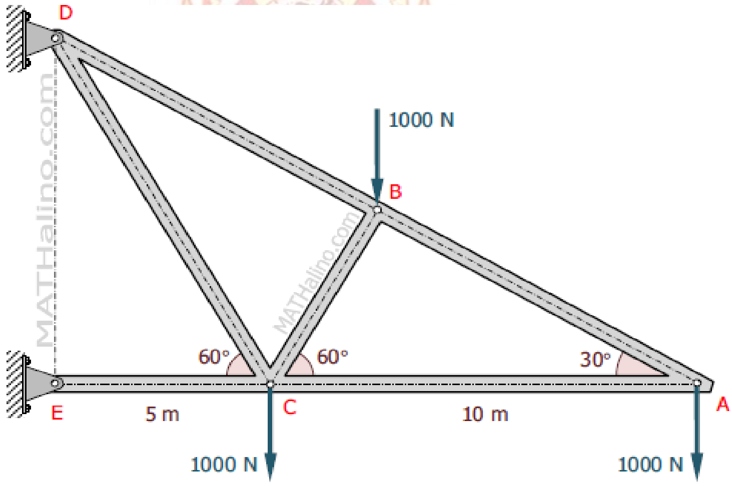


Figure P-406

48. **Determine the force in the members BC, CE and EF of the truss of problem 5 using method of sections.**

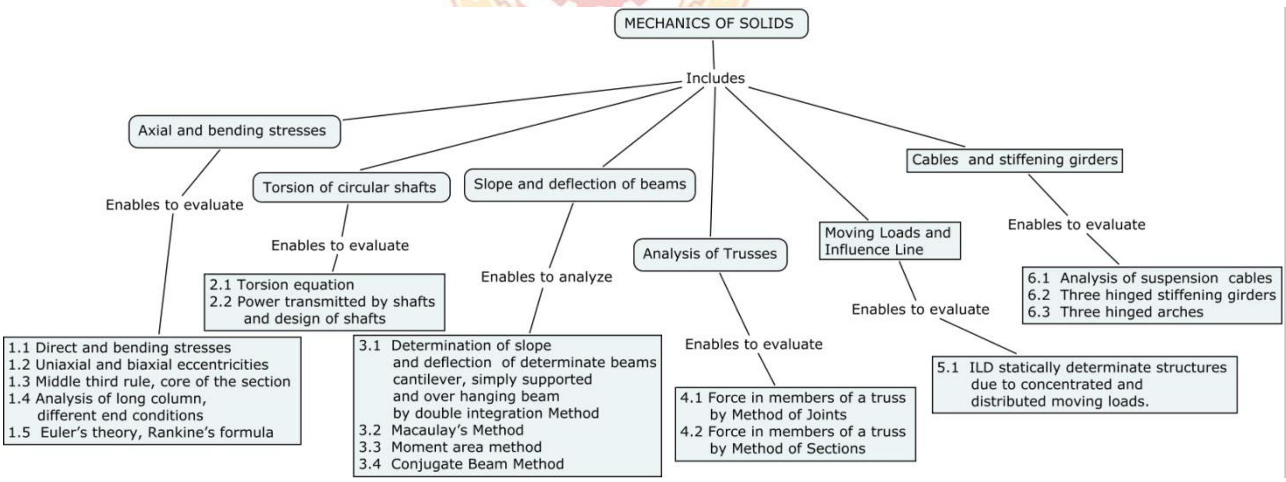
Course Outcome 5 (CO5):

49. **Mention the propositions related to two point loads.**
50. **A uniformly distributed load of intensity 30kN/m crosses a simply supported beam of span 60m from left to right. The length of udl is 15m. Find the value of maximum bending moment at a section 20m from left end. Find also the absolute maximum bending moment and shear force in the beam.**
51. **Construct the influence line diagram for shear force at section 3m and for bending moment at 4m for a simply supported beam of span 6m. Using the influence line diagram, obtain the shear force at 3m and bending moment at 4m if the beam is subjected to two point loads of 15kN and 20kN at 1.5m and 4.5m respectively.**

Course Outcome 6 (CO6):

1. **A suspension cable 100m span and 15m dip is stiffened with a three hinged girder. If a concentrated load of magnitude 100kN crosses the span, determine the maximum tension in the cable. Also, determine the greatest bending moment and shear force in the stiffening girder. State the position of the load in the above cases.**
2. **A light cable 18m long is supported at two ends at the same level. The supports are 16m apart. The cable supports 120N load dividing the distance into two equal parts. Find the shape of the cable and the tension in the cable.**
3. **A three hinged symmetric parabolic arch of span 60m and rise 12m is subjected to a concentrated load of 40kN acting at a distance 10m from its left support and a uniformly distributed load of intensity 10kN/m acting over its entire right half portion. Draw the bending moment diagram**

Concept Map



Syllabus

Axial and bending stresses: Direct and bending stresses – uniaxial and biaxial eccentricities – middle third rule – core of the section – analysis of long column – different end conditions – Euler's theory – Rankine's formula.**Torsion of circular shafts:** Introduction – derivation of torsion equation – assumptions – power transmitted by shafts – design of shafts. **Slope and deflection of beams:** Determination of slope and deflection of determinate beams – cantilever, simply supported and over hanging beam - Double Integration Method, Macaulay's Method, Moment area Method and Conjugate Beam Method. **Analysis of Trusses:** Force in members of a truss – Method of Joints – Method of Sections. **Moving Loads and Influence Line:** Influence lines for reactions, shear force and bending moment in statically determinate structures due to concentrated and distributed moving loads. **Cables , stiffening girders and arches:** Analysis of cables, three hinged stiffening girders and three hinged arches

Text Book

1. Roger T. Fenner, J.N. Reddy., Mechanics of solids and Structures second Edition, CRC Press - 2012
2. Punmia, B.C., Arun Kumar, Ashok Kumar., Theory of structures, Laxmi Publications, New Delhi, 2002.

Reference Books

1. S S Rattan., Strenth of Material, McGraw Hill Educational Private (india)Limited.2011
2. Bhavikatti S S, “Structural Analysis”, Vikas Publishing House Pvt. Ltd, New Delhi. 2009
3. Rajput., Strength of materials, S.Chand publishers, 4th edition, 2006
4. Thandavamoorthy, ‘‘Analysis of Structures”, Oxford &IBH Publishers, New Delhi.2008
5. Junnarkar, S.B. & Shah, H.J.., Mechanics of structures, vol.I, II, Charotar Publishing House, India, 1999
6. NPTEL material http://nptel.ac.in/courses/105106116/

Course Content

Module No.	Topic	No. of Lectures
1.0	**Axial and Bending Stresses**	
1.1	Direct and bending stresses	1
1.2	Uniaxial and biaxial eccentricities	1
	Tutorial	2
1.3	Middle third rule, core of the section	1
1.4	Analysis of long column,different end conditions	2
	Tutorial	3
1.5	Euler’s theory, Rankine’s formula	2
	Tutorial	2
2.0	**Torsion of circular shafts**	
2.1	Introduction, derivation of torsion equation	1
2.2	Power transmitted by shafts and design of shafts	2
	Tutorial	3
3.0	**Slope and deflection of beams**	
3.1	Determination of slope and deflection of determinate beams – cantilever, simply supported and over hanging beam by double integration Method	2
	Tutorial	2
3.2	Macaulay’s Method	1
	Tutorial	1
3.3	Moment area method	1
	Tutorial	1
4.0	**Analysis of Trusses**	
4.1	Force in members of a truss by Method of Joints	2

Module No.	Topic	No. of Lectures
	Tutorial	2
4.2	Force in members of a truss by Method of Sections	2
	Tutorial	2
5.0	**Moving Loads and Influence Line**	
5.1	Influence lines for reactions, shear force and bending moment in statically determinate structures due to concentrated and distributed moving loads.	2
	Tutorial	2
6.0	**Cables, Suspension Bridges and Arches**	
6.1	Analysis of suspension cables	1
6.2	Three hinged stiffening girders	1
	Tutorial	2
6.3	Three hinged arches	2
	Tutorial	2
	Total hours (24 Theory + 24 Tutorials)	**48**

Course Designers:

1. Dr. B. Sivagurunathan sivagurunathan@tce.edu
2. Dr. S. Nagan nagan_civil@tce.edu

14CE330	FLUID MECHANICS	Category	L	T	P	Credit
		PC	3	0	0	3

Preamble

Fluid Mechanics is a subject of engineering science deals with the behaviour of fluids at rest as well as in motion. It is an important subject with unlimited practical applications ranging from biological system systems to automobiles, airplanes and spacecraft propulsion. Thus this subject is given considerable importance in Civil, Mechanical and Chemical Engineering at core as well as at professional levels.

Prerequisite

Fundamentals knowledge of Engineering Mathematics and Physics

Course Outcomes

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

On the successful completion of the course, students will be able to:		Expected Attainment level in%	Expected Proficiency Level in grade
(CO1) Find the basic properties of fluids and their application in real world problems.	**Apply**	**70**	**A**
(CO2) Compute the variation of pressure in fluid at rest and calculate the hydrostatic forces and point of application on a plane or curved surface.	**Apply**	**70**	**A**
(CO3) Derive the continuity equation for compressible and incompressible flow	**Apply**	**70**	**A**
(CO4) Apply Bernoulli's equation to solve a variety of fluid flow problems.	**Apply**	**70**	**A**
(CO5) Estimate the major and minor losses in pipe flow and calculate the flow through pipes connected in series and in parallels	**Apply**	**70**	**A**
(CO6) Determine the boundary layer thickness and other boundary layer properties	**Understand**	**70**	**A**

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO9.	S	S	-	-	-	-	-	-	-	-	-	-	L	-
CO10.	S	S	L	L	-	L	-	-	-	-	-	-	M	L
CO3.	S	S	-	S	-	-	-	-	-	-	-	-	M	-
CO4.	S	S	-	S	-	-	-	-	-	-	-	-	M	-
CO5.	S	S	L	M	-	L	-	-	-	-	-	-	M	L

CO6.	M	M	-	-	-	-	-	-	-	-	-	-	L	-

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	20	20	20	20
Apply	60	60	60	60
Analyse	---	---	---	---
Evaluate	---	---	---	---
Create	---	---	---	---

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. State Newton's law of viscosity. Give examples for Newtonian fluids.
2. A cylindrical shaft of 90mm diameter rotates about a vertical axis inside a fixed cylindrical tube of length 50cm and 95mm diameter. If the space between the tube and shaft is filled by a lubricant of viscosity 2 poise, determine the power required to overcome viscous resistance when the shaft is rotated at a speed of 240 rpm
3. The space between the two square flat parallel plates is filled with oil. Each side of the plate is 75cm. The thickness of the oil film is 15mm. The upper plate which moves at 3m/s requires a force of 120N to maintain the speed, Determine (i) The dynamic viscosity of oil and (ii) The kinematic viscosity of oil, if the specific gravity of oil is 0.95.
4. A mass of liquid weighs 500 N when exposed to standard earth's gravity g = 9.81m/s^2. (i) What is its mass? and (ii) What will be its weight in a planet with acceleration due to gravity of 3.5m/s^2.

Course Outcome 2 (CO2):

1. Convert 1kg/cm^2 into equal head of water and mercury
2. U tube differential mercury manometer is connected on one side to pipe A containing oil of specific gravity 1.5 while on the other side to pipe B containing oil of specific gravity 0.9. The pipe A lies 3m below pipe B. The mercury level in the limb communicating with pipe A lies 2m below the center of pipe A and 3m below center of pipe B in the limb communicating with pipe B. Determine the difference in pressure between the two pipes.
3. A 6m deep tank contains 4 m of water and 2 m of oil of relative density 0.88. Determine the pressure at the bottom of the tank and at the interface of two liquids.
4. Find the pressure represented by a column of (i) 10 cm of water, (ii) 5 cm of oil of relative density 0.75 and (iii) 2 cm of mercury.

Course Outcome 3 (CO3)

1. Prove that the total energy at any point of the fluid is constant for ideal steady incompressible fluid flow.
2. Obtain relevant stream function for the given velocity components of steady incompressible flow, u = x + y and v = x – y
3. The diameters of a pipe at the sections X and Y are 10 cm and 20 cm respectively. Find the discharge through the pipe if the velocity of water flowing through the pipe at X is 3.0 m/s. Also find the velocity at section Y.

Course Outcome 4 (CO4)

1. List the forces acting on a fluid flow. Mention the forces accounted for deriving Euler's equation of motion
2. A pipe carrying water has a 30 cm x 15 cm venturimeter which is positioned inclined at 30^0 to the horizontal. The flow is upwards. The converging cone is 45 cm in length and C_d = 0.98. A differential U tube mercury manometer connected to inlet and throat shows a reading of 30 cm. (i) Calculate the discharge in the pipe and (ii) If the pressure at the inlet is 50 N/cm^2, determine the pressure at the throat.
3. In a smooth pipe of uniform diameter 25cm a pressure of $50N/cm^2$ was observed at section 1 which was at elevation of 10m. At another section 2 at elevation of 12m the pressure was $20N/cm^2$ and the velocity was 1.25m/s. Determine the direction of flow and the head loss between the two sections. Water is flowing through the pipe.

Course Outcome 5 (CO5)

1. Consider a laminar flow through a pipe, draw the velocity distribution and shear stress distribution across the pipe.
2. Derive Darcy Weisbach formula of finding the loss of head due to friction in pipes.
3. Derive an expression for finding the loss of head due to viscous flow through a circular pipe.
4. An oil of viscosity 8 poise and specific gravity 0.9 is flowing through a horizontal pipe of 50 mm diameter. If the pressure drop in 100m length of the pipe is 2000 kN/m^2, determine (i) Rate of flow of oil, (ii) Centre line velocity, (iii) Total frictional drag over 100m length of pipe and (iv) Velocity and shear stress at 10 mm from the wall. Assume laminar flow through the pipe

Course Outcome 6 (CO6)

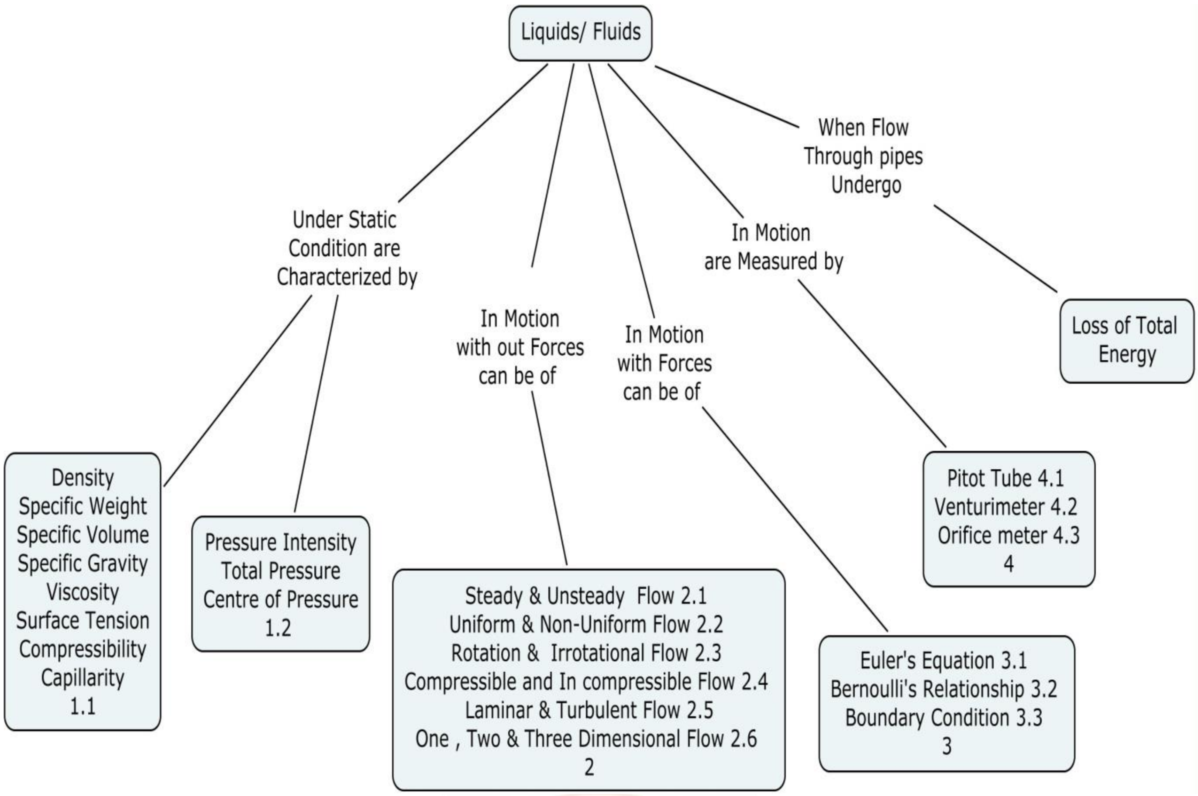
1. Draw the HGL and TEL for a uniform diameter pipe, its one end is connected to the bottom of tank and the other end is open to atmosphere.
2. An existing 30 cm diameter pipeline of 3.2 km length connects two reservoir with 13 m difference in their water levels. Calculate the discharge. If a parallel pipe of 30 cm diameter is attached to the last 1.6 km length of the existing pipe, find the new discharge.
3. The difference in water surface levels in two tanks which are connected by three pipes in series of length 350 m, 200 m and 250 m and diameters 20 cm, 30 cm and 15 cm respectively is 20 m. Determine the rate of flow of water, if coefficient of friction for these pipes is same and equal to 0.005 by considering all losses.

4. A reservoir discharges its liquids through a horizontal pipeline into the atmosphere. The pipeline consists of two pipes, one of 10 cm diameter and 25 m long and another 12 cm diameter and 35 m long connected in series. The friction coefficient f = 0.005 for both the pipes. The water level in the tank is 10 m above centre line of the pipe at the entrance. Calculate the discharge when the 10 cm diameter pipe is joined to the tank.

Course Outcome 7 (CO7)

1. Define displacement thickness in connection with boundary layer.
2. Describe the development of boundary layer and its importance with neat sketch.
3. Find the displacement thickness, momentum thickness, energy thickness and shape factor for the velocity distribution in the boundary layer is given by $u / U = (y / \delta)^{1/7}$ where δ = boundary layer thickness.
4. The velocity distribution in the boundary layer is given by $u / U = y / \delta$, where u is the velocity at a distance of y from the plate and u = U at y = δ, δ being boundary layer thickness. Find the displacement thickness, momentum thickness, energy thickness and shape factor.

Concept Map



Syllabus

Fluid Statics: Fluid properties like density, specific weight, specific volume, specific gravity, viscosity, surface tension, compressibility, capillarity and types of fluids. **Pressure Measurements:** Pascal's law, Hydrostatic law, Manometers, Pressure gauges, total pressure and centre of pressure on submerged surfaces, metacentre and metacentric height. **Fluid Kinematics:** Classification of fluid flows, continuity equation, potential function and stream function. **Fluid Dynamics:** Euler's equation, Bernoulli's equation and its application. **Flow Measurements:** Discharge measurement in pipes using Pitot tube, Venturimeter and Orificemeter. Boundary layer theory and its application. **Flow through pipes:** Reynold's experiment, Laminar and turbulent flow through circular pipes, major and minor losses in pipes, flow through syphon, pipes in series and parallel.

Text Book

2. **Modi P.N and Seth S.M, "Hydraulics and Fluid Mechanics Including Hydraulic Machines" Standard Book House" New Delhi, 20th Edition 2015**

Reference Books

13. **Yunus A. Cengel and John M. Cimbala, "Fluid Mechanics" Fundamentals and Applications, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2010**
14. **Bansal R.K, "A Text Book of Fluid Mechanics and Hydraulic Machines" Lakshmi Publications, New Delhi, 2010**
15. **Kumar.K.L, "Engineering Fluid Mechanics" S.Chand Ltd., New Delhi, 2008.**
16. **Subramanya, K, "Fluid Mechanics and Hydraulic Machines Problems and Solutions" Tata McGraw Hill Publishing Company Ltd, New Delhi, 2010.**

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Properties of fluids and fluid statics**	
1.1	Basic concepts of fluid mechanics, types of fluids	1
1.2	Different Properties of fluids	1
1.3	Problems on properties of fluids	2
2	**Pressure and its measurement**	
2.1	Pascal's law, Hydrostatic law	1
2.2	Types of manometers and its applications	2
2.3	Total pressure and centre of pressure	2
2.4	Metacentre and metacentric height	1
3	**Fluid Kinematics**	
3.1	Classification of fluid flows	1
3.2	Continuity equation for three dimensional incompressible flow and problems	2
3.3	Concept of velocity potential function and stream function with problems	2
4	**Fluid Dynamics**	
4.1	Forces acting on fluid flow	1
4.2	Derivation of Euler's and Bernoulli's equation	1
4.3	Problems to find the energy of the flowing fluid	2
5	**Flow Measurement**	
5.1	Pitot-tube and its application	1
5.2	Venturimeter and its applications	2
5.3	Orificemeter and its application	1
5.4	Development of boundary layer thickness and its application	1
5.5	Problems on boundary thickness	2
6	**Flow through pipes**	
6.1	Reynold's experiment to determine the type of flow	1
6.2	Hagen Poiseuille equation	1
6.3	Problems on laminar flow through pipes	1
6.4	Turbulent flow, Darcy Weisbach equation	1
6.5	Problems on turbulent flow through pipes	1
6.6	Major and minor losses in pipes	2
6.7	Flow through syphon pipe	1
6.8	Pipes in series and parallel and problems	2
	Total Hours	**36**

Course Designers:

1. **Mr. M. Ramasamy** mrciv@tce.edu
2. **Dr. T. Baskaran** tbciv@tce.edu

		Category	L	T	P	Credit
14CE340	**WATER SUPPLY ENGINEERING**	HSS	3	0	0	3

Preamble

This course work aims at imparting the knowledge on various stages of works involved in planning, designing and execution of protected water supply system to a town/city. Starting from demand estimation, identification of sources, studying the quality aspects of water at these sources, evolving a suitable treatment method to bring the quality to the permissible standards and finally, distribution of this treated water to the individual dwelling units are well addressed.

Course Outcomes

On the successful completion of the course, students will be able to:		**Expected Attainment Level in%**	**Expected Proficiency Level in grade**
CO1. Estimate the total water demand for a town/city	Apply	**70**	**A**
CO2. Identify suitable sources of water to meet the demand	Understand	**70**	**A**
CO3. Design the conduits for transportation of water from the source to treatment plant and to the city	Apply	**70**	**A**
CO4. Prepare the physical, Chemical and biological characteristics of different sources of water	Understand	**70**	**A**
CO5. Design an appropriate treatment system for the water available at the source	Apply	**70**	**A**
CO6. Design a good water distribution system for an individual building and for a community.	Apply	**70**	**A**

Mapping with Programme Outcomes

Cos	**PO1**	**PO2**	**PO 3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO11.	S	L	L	L	-	-	S	-	-	-	-	-	M	L
CO12.	S	S	M	M	-	-	S	-	-	-	-	-	M	L
CO3.	S	S	S	S	-	-	M	-	-	-	-	-	M	M
CO4.	S	S	L	S	-	**S**	S	M	M	-	L	-	L	L
CO5.	S	S	S	S	-	-	S	M	-	-	L	-	M	M
CO6.	S	S	S	S	-	-	S	-	-	-	L	-	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	

Remember	**20**	**20**	**20**	**20**
Understand	**40**	**40**	**40**	**40**
Apply	**40**	**40**	**40**	**40**
Analyse	**--**	**--**	**--**	**--**
Evaluate	**--**	**--**	**--**	**--**
Create	**--**	**--**	**--**	**--**

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Identify design period for different components of water supply system
2. Describe fluctuation in water demand
3. Explain the factors affecting per capita demand of a city
4. Identify a suitable method for prediction future population of a rapidly growing city

Course Outcome 2 (CO2):

1. List the different groundwater sources available
2. Explain the factors influencing the selection of a particular source of water for a town
3. Show the importance of selection of an appropriate site for a river intake

Course Outcome 3 (CO3):

1. Distinguish gravity system from pumping system of water supply
2. **A water supply scheme is to be designed for serving a population of 6.0 Lakhs, the storage reservoir is situated at 15 Km away from the city and the loss of head from the source to the city is 20m. Calculate the size of the supply main using Darcy and Hazen William formula. Take f = 0.012, C_H =130 and maximum daily demand as 200 lpcd. The entire day demand is to be supplied in 10 hours.**

Course Outcome 4 (CO4):

1. Demonstrate the procedure for fixing biological character for water
2. Distinguish safe water from wholesome water
3. Identify the importance of chemical characters of water

Course Outcome 5 (CO5):

1. Describe the mechanisms of removal in filtration process
2. Explain the theory of chlorination and the factors affecting chlorination
3. Design a rapid sand filter to treat 10 million litres of raw water per day allowing 0.5% of filtered water for backwashing. Half hour per day is used for backwashing. Assume necessary data.

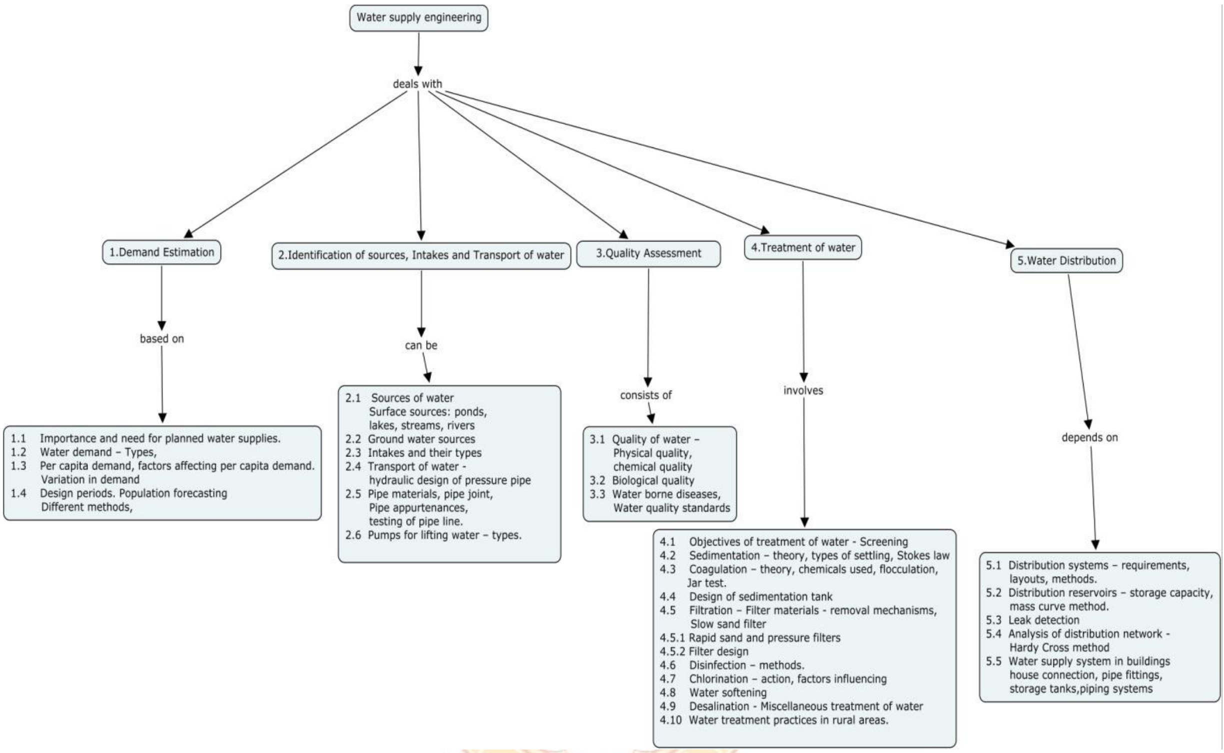
Course Outcome 6 (CO6):

1. Explain the merits of grid iron system over dead end system
2. Demonstrate the procedure for detecting leakages in a pipe main
3. A town with a population of 1 million has a continuous water supply. Average supply in 270LPCD, the water being supplied by direct pumping. The total supply of 270 lpcd is phased as follows:

Time	**Lpcd**
5A.M to 11 A.M	90
11A.M to 3 P.M	54
3 P.M to 9 P.M	81
9 P.M to 12 Midnight	27
12 Midnight to 5 A.M	18

Water is supplied from the treatment plant at a uniform rate of 11.25 million litres per hour, for all the 24 hours. Find out the capacity of the reservoir required for distribution of water. Assume no loss or drawal from the trunk main

Concept Map



Syllabus

Demand Estimation - Importance and need for planned water supplies - water demand – Types, per capita demand, factors affecting per capita demand - variation in demand – Design periods - population forecasting – different methods. **Identification of sources, Intakes and Transport of water -** Sources of water - Surface sources - ponds, lakes, streams, rivers - Ground water sources - occurrence, aquifers and their types – Wells - open wells, Tube wells - springs and their types - Infiltration galleries - Infiltration wells - Intakes and their types. Transport of water - hydraulic design of pressure pipe - Pipe materials - pipe joints - pipe appurtenances, testing of pipe line - Pumps for lifting water – types. **Quality Assessment** - Quality of water – Physical quality, chemical quality, Biological quality - water borne diseases - Water quality standards. **Treatment of water** – Screening - Sedimentation – theory, types of settling, Stokes law - Coagulation – theory, chemicals used, flocculation - Jar test – design of sedimentation tank - Filtration – removal mechanisms, filter media, types, slow sand, rapid sand and pressure filters, filter design. Disinfection – methods. Chlorination – action, factors influencing, free chlorination, combined chlorination – ozonation, UV radiation – water softening – Desalination – Reverse Osmosis - Miscellaneous treatment of water - water treatment practices in rural areas. **Water Distribution** - Distribution systems – requirements, layouts and methods - Distribution reservoirs – storage capacity, mass curve method - Leak detection - Analysis of distribution network - Hardy Cross method - Water supply system in buildings – house connection, pipe fittings, storage tanks, piping systems.

Text Book

17. Garg S.K “Water Supply Engineering”, Khanna Publishers, 12th Edition, New Delhi 2005.

Reference Books

18. Steel E.W., “Water Supply and sewerage”, Mc Graw Hill Publishers, New Delhi. 1991
19. Peavy, Rowe, Tchobanoglous, “Environmental Engineering”, McGraw Hill Publishers, New Delhi. 1995

20. Birdie G.S and Birdie J.S “Water Supply and Sanitary Engineering” Dhatpat Rai Publishing Company New Delhi, 7th edition 2004
21. Gilbert M. Masters , “ Introduction to Environmental Engineering and Science”, third Edition, 2008
22. Manual on Water Supply and Treatment, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2003
23. Chatterjee A.K. Water Supply, Waste Disposal and Environmental Engineering, 8th ed., New Delhi, Khanna Publisher. 2010
24. IS10500:2012 Water Quality Standards ,New Delhi 2012

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	Demand Estimation	
1.1	**Importance and need for planned water supplies.**	**1**
1.2	**Water demand – Types,**	**1**
1.3	**Per capita demand, factors affecting per capita demand. Variation in demand**	**1**
1.4	**Design periods. Population forecasting – Different methods,**	**2**
2	Identification of sources, Intakes and Transport of water	
2.1	**Sources of water: Surface sources: ponds, lakes, streams, rivers**	**1**
2.2	**Ground water sources**	**1**
2.3	**Intakes and their types**	**1**
2.4	**Transport of water - hydraulic design of pressure pipe**	**2**
2.5	**Pipe materials, pipe joint, Pipe appurtenances, testing of pipe line.**	**1**
2.6	**Pumps for lifting water – types.**	**1**
3	Quality Assessment	
3.1	**Quality of water – Physical quality, chemical quality**	**1**
3.2	**Biological quality**	**1**
3.3	**Water borne diseases, Water quality standards**	**1**
4	Treatment of water	
4.1	**Objectives of treatment of water - Screening**	**1**
4.2	**Sedimentation – theory, types of settling, Stokes law**	**1**
4.3	**Coagulation – theory, chemicals used, flocculation, Jar test.**	**1**
4.4	**Design of sedimentation tank**	**2**
4.5	**Filtration – Filter media - removal mechanisms, Slow sand filter**	**1**
4.5.1	**Rapid sand and pressure filters**	**1**
4.5.2	**Filter design**	**2**
4.6	**Disinfection – methods, Ozonation and UV radiation**	**1**
4.7	**Chlorination – action, factors influencing**	**1**
4.8	**Water softening**	**1**
4.9	**Desalination – Reverse Osmosis - Miscellaneous treatment of water**	**1**
4.10	**Water treatment practices in rural areas.**	**1**
5	Water Distribution	
5.1	**Distribution systems – requirements, layouts, methods.**	**1**
5.2	**Distribution reservoirs – storage capacity, mass curve method.**	**2**
5.3	**Leak detection**	**1**
5.4	**Analysis of distribution network - Hardy Cross method**	**2**
5.5	**Water supply system in buildings – house connection, pipe fittings, storage tanks, piping systems.**	**1**
	Total hours	36

Course Designers:

1. Dr. T. Vel Rajan tvciv@tce.edu
2. Mr. P. Balakrishnan balakrishnancivil@tce.edu

14CE351	CONCRETE TECHNOLOGY	Category	L	T	P	Credit
		PC	3	0	0	3

Preamble

Concrete Technology focuses more on detailed understanding of concrete making materials and production process. Recent developments in concrete materials are also given adequate consideration. Going through the course, student would develop adequate understanding on concrete production process and properties and uses of concrete as a modern material of construction. The course will also enable the student to make appropriate decision regarding ingredient selection and use of concrete.

Course Outcomes

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

ith Programme Outcomes

CO1. Explain the properties and tests of various constituents present in concrete	**Understand**
CO2. Understand various manufacturing process of concrete and properties and workability tests of fresh concrete	**Understand**
CO3. Design concrete mix as per IS and ACI standards	**Apply**
CO4. Enumerate the mechanical behaviour and properties of hardened concrete	**Understand**
CO5. Demonstrate the long term properties of concrete and identify the solutions for field problems	**Apply**
CO6. Select the suitable type of special concrete for real time situations	**Apply**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO13	-	-	-	-	-	-	S	-	-	M	L	L	M	L
CO14	-	-	-	-	-	-	S	L	-	M	L	L	M	M
CO3	L	L	M	M	-	-	S	S	-	-	L	M	S	M
CO4	-	-	-	-	-	-	S	-	-	-	L	M	M	M
CO5	-	-	-	-	-	-	S	-	-	S	S	M	S	S
CO6	-	-	-	M	-	S	S	S	M	-	M	S	S	S

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	60	40	20	20
Apply	20	40	60	60
Analyze	--	--	--	--
Evaluate	--	--	--	--
Create	--	--	--	--

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. **Differentiate admixtures and additives.**
2. **Define specific gravity and bulk density.**
3. **Explain the process of hydration of cement.**

Course Outcome 2 (CO3):

1. **Explain the various factors influencing the workability of concrete.**
2. **Define the term laitance.**
3. **Summarize the methods of curing of concrete.**

Course Outcome 3 (CO2):

1. **Solve suitable concrete mix for M40 concrete for the following concrete.**
   - i. Characteristic strength on concrete at 28 days : 40N/mm^2
   - ii. Ordinary Portland Cement of 53 grade
   - iii. Degree of Workability : 75 – 100 mm slump
   - iv. Degree of Exposure : Mild
   - v. Maximum size of Aggregate : 20 mm
   - vi. Specific Gravity of Coarse Aggregate : 2.75
   - vii. Specific Gravity of Coarse Aggregate : 2.63
   - viii. Specific Gravity of Cement : 3.05
   - ix. Degree of Quality control : Good.

2. **Design a suitable concrete mix with the following particulars using IS 10262-1982.**
   - x. Characteristic strength on concrete at 28 days : 20N/mm^2
   - xi. Ordinary Portland Cement of 53 grade
   - xii. Degree of Workability : 50-75 mm slump
   - xiii. Degree of Exposure : Mild
   - xiv. Maximum size of Aggregate : 20 mm
   - xv. Specific Gravity of Coarse Aggregate : 2.7
   - xvi. Specific Gravity of Coarse Aggregate : 2.6
   - xvii. Specific Gravity of Cement : 3.15
   - xviii. Degree of Quality control : Good.

3. **Construct the step by step procedure of concrete mix design as per ACI method**

Course Outcome 4 (CO4):

1. **Define water cement ratio and gel space ratio.**
2. **Construct the procedure to determine the tensile strength of concrete.**
3. **Discuss the various types of non destructive testing methods**

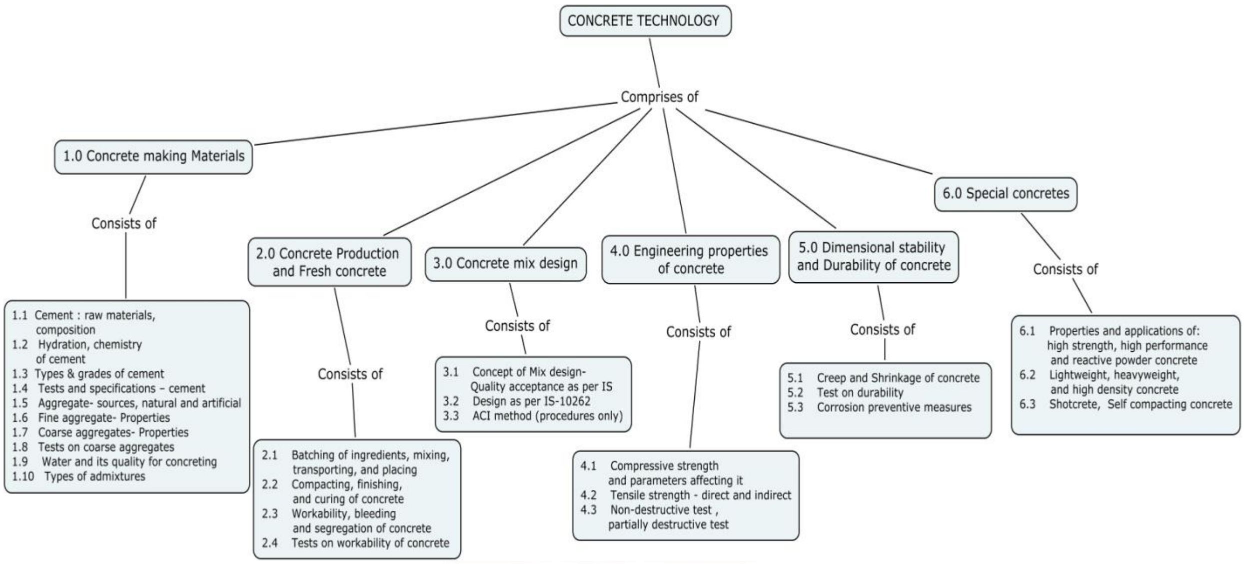
Course Outcome 5 (CO5):

1. **Identify the type of shrinkage and rectify the problem.**
2. **Select suitable type of protective measures may apply on rebars against corrosion.**
3. **A RCC structure is to be constructed in a marine environment. Discuss the various preventive measures you would recommend to make the structure safe against corrosion of rebars.**

Course Outcome 6 (CO6):

1. **Choose the suitable special concrete that can be used for the following situations and explain briefly.**
   a. To reduce the self weight of the structure.
   b. To enhance the tensile strength of concrete.
   c. Shuttering and formwork is not possible.
2. Differentiate light weight and heavy weight concrete.
3. Choose the suitable type of concrete for congested reinforced area.

Concept Map



Syllabus

Concrete making Materials:

Cement- raw materials, composition - Hydration, chemistry of cement – Types and grades of cement - Tests and specifications – consistency, setting time, soundness and fineness test. **Aggregates** - source, natural and artificial. **Fine aggregates**- gradation, fineness modulus, specific gravity, bulk density , bulking of sand, water absorption, moisture content and measurement methods, presence of deleterious content . **Coarse aggregates** – size and shape, gradation, fineness modulus, specific gravity, bulk density sieve analysis, water absorption. Tests on coarse aggregates- impact, crushing, abrasion and attrition, water absorption, alkali aggregate reaction. **Water-** Qualities of water for concreting, tolerable concentrations of impurities, use of sea water and its effects. **Admixtures** - Types of Admixtures- super plasticisers, plasticisers, retarders, accelerators, air entrained admixtures and pozzolanic admixtures **Concrete Production & Fresh concrete**: Batching of ingredients; mixing, transporting, and placing - Compacting, finishing, and curing of concrete - Workability, bleeding and segregation of concrete - Factors influencing it - Tests on workability of concrete. **Concrete mix design:** Concept of Mix design-Quality acceptance criteria as per Indian standard method. Design of concrete mixes as per IS-10262, ACI method (procedure only). **Engineering properties of concrete:** Compressive strength and parameters affecting it - Tensile strength - direct and indirect; Modulus of elasticity and Poisson's ratio, flexural strength of concrete- Non-destructive test , partially destructive test.

Dimensional stability and Durability of concrete: Creep - parameters affecting - Shrinkage of concrete - types and its significance - Introduction to durability; relation between durability and permeability - Chemical attacks on concrete- sulphate attack, chloride, acid attacks, sea water attacks, carbonation attacks - Corrosion of steel rebars, corrosion preventive measures. **Special concretes:** Properties and applications of: high strength, high performance and reactive powder concrete - Lightweight, heavyweight, and high density concrete, Shotcrete, Self compacting concrete

Text Book

1. Shetty M.S., "Concrete Technology", 7th edition, S.Chand and company Limited, 2012.
2. Nevile A.M., "Properties of concrete", 5th edition, Pearson India, 2012.

Reference Books

1. Mehta, P.K., "Concrete: Microstructure, Properties and Materials " 4th edition, Tata McGraw Hill Education Private Limited, 2013
2. Gambhir, "Concrete Technology", 5th edition, McGraw Hill Education (India) Private Limited, 2013.
3. Santha Kumar A.R., "Concrete Technology", Oxford University Press, New Delhi, 2009.
4. www.nptel.ac.in

IS Codes

1. IS: 10262-2009, Recommended guidelines for Concrete Mix Design.
2. IS: 456 - 2000, Plain and Reinforced concrete – code of practice
3. SP: 23-1982, Handbook on concrete.
4. ACI Committee 2111.1- 91, standard practice for selecting proportions for normal, heavy weight and mass concrete, Part I, ACI manual of concrete practice, 1994.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	**Concrete making Materials**	
1.1	Cement : raw materials, composition	1
1.2	Hydration, chemistry of cement	1
1.3	Types & grades of cement	2
1.4	Tests and specifications – consistency, setting time, soundness test, fineness test, chemical analysis	2
1.5	Aggregate- sources, natural and artificial	1
1.6	Fine aggregate- bulking of sand, presence of deleterious content, water absorption and moisture content	1
1.7	Coarse aggregates – size and shape, gradation, fineness modulus, specific gravity, bulk density sieve analysis, water absorption.	1
1.8	Tests on coarse aggregates- impact, crushing, abrasion and attrition,	2

Module No.	Topic	No. of Lectures
	water absorption, alkali aggregate reaction	
1.9	Water and its quality for concreting	1
1.10	Types of admixtures – super plasticisers, plasticisers, retarders, accelerators, air entrained admixtures and pozzolanic admixtures	2
2.0	**Concrete Production & Fresh concrete**	
2.1	Batching of ingredients, mixing, transporting, and placing	2
2.2	Compacting, finishing, and curing of concrete	2
2.3	Workability, bleeding and segregation of concrete - Factors influencing it	2
2.4	Tests on workability of concrete	1
3.0	**Concrete mix design**	
3.1	Concept of Mix design-Quality acceptance criteria as per IS	1
3.2	Design as per IS-10262	2
3.3	ACI method (procedures only)	2
4.0	**Engineering properties of concrete**	
4.1	Compressive strength and parameters affecting it	1
4.2	Tensile strength - direct and indirect; Modulus of elasticity and Poisson's ratio, flexural strength of concrete	2
4.3	Non-destructive test , partially destructive test	1
5.0	**Dimensional stability and Durability of concrete**	
5.1	Creep and Shrinkage of concrete	1
5.2	Test on durability – Chemical attacks of concrete, Corrosion of steel rebars	2
5.3	Corrosion preventive measures	1
6.0	**Special concretes**	
6.1	Properties and applications of: high strength, high performance and reactive powder concrete	1
6.2	Lightweight, heavyweight, and high density concrete	1
6.3	Shotcrete, Self compacting concrete	1
	Total hours	**36**

Course Designers:

1. Dr.K.Arunachalam hodciv@tce.edu
2. Dr.D.Brindha dbciv@tce.edu

14CE360	PROBLEM SOLVING USING COMPUTER	Category	L	T	P	Credit
		ES	3	0	0	3

Preamble

The course on problem solving using computers is intended to introduce the students to computational thinking, methodology of programming with emphasis on modularity and the coding of computer programs. Upon completion of the course, the students would be able to master the principles of structured programming and demonstrate significant experience in problem solving.

Prerequisite

- Nil

Course Outcomes

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

		I	Expected Attainment Level in %	Expected Proficiency Level in grade
CO1:	Comprehend and practice the following terms in the context of problem solving by a computer: Problem specification, input-output analysis, algorithm, flowchart, pseudo-code, High level language, assembly language, machine language, and compilation and execution.	Apply		
CO2:	Develop simple programs in C language involving constants and variables, operators and expressions, arrays, input and output statements, control and iterative statements by appropriate choice of data types, expressions and control structures.	Analyze		
CO3:	Apply problem solving strategies such as divide and conquer, merging, solving by analogy etc in design of simple applications. (Including applications from Surveying like Simpson’s rule and Flow problems using discharge (Ex: Diverging pipes), Bernoulli’s theorem, continuity equation)	Apply		
CO4:	Utilize structures and unions in development of simple applications like payroll management, Grade calculation etc.	Apply		
CO5:	Deploy the concept of Dynamic memory allocation and pointers for simple programs like matrix manipulation, stack implementation etc.	Apply		

CO6:	Utilize the extensive set of library functions available in C for creating and processing data files.	Apply
CO7:	Develop simple applications in team for simple engineering problem in C language (Civil applications :Shear force, Bending moment, slope and deflection calculations of various beams with different loading conditions, Centre of gravity and Moment of Inertia)	Apply

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1.	M	-	-	-	-	-	-	-	-	-	-	-		
CO2.	M	-	-	-	-	-	-	-	-	-	-	-		
CO3.	M	L	L	-	-	-	-	-	-	-	-	-		
CO4.	M	L	L	-	-	-	-	-	-	-	-	-		
CO5.	M	L	L	-	-	-	-	-	-	-	-	-		
CO6.	M	L	L	-	-	-	-	-	-	-	-	-		
CO7.	M	M	M	-	S	-	-	L	L	L	L	L		

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment			Terminal Examination
	Test 1	Test 2	Test 3	
Remember	**20**	**20**	**20**	**10**
Understand	**40**	**20**	**40**	**20**
Apply	**40**	**50**	**50**	**50**
Analyze	**0**	**10**	**10**	**20**
Evaluate	**0**	**0**	**0**	**0**
Create	**0**	**0**	**0**	**0**

Attainment of Course outcome 7 is evaluated through Mini Project which involves design and development of simple engineering applications using modular programming.

Course Level Assessment Questions

Course Outcome 1 (CO1):

4. **Differentiate a compiler and interpreter.**
5. **Draw the flowchart for generation of Fibonacci sequence.**
6. **Develop the algorithm for exchange of two variables.**

Course Outcome 2 (CO2):

7. **Determine the hierarchy of operations and evaluate the expression k=3/2*4+3/8+3 and convert the equation** $z = \frac{\frac{8.8(a+b)2}{c} - 0.5 + 2a/(q+r)}{(a+b)*(\frac{i}{m})}$
8. Rewrite the following program using conditional operators.

main()

{

floatsal;

```
printf(“ENTER SALARY”);
scanf(“%f”,&sal);
if(sal<40000 &&sal>25000)
printf(“MANAGER”);
else
if(sal<25000 &&sal>15000)
printf(“ACCOUNTANT”);
else
printf(“CLERK”);
}
```

9. Evaluate the output of the following code:

```
main()
{
int x=4,y=0,z;
while (x>=0)
{
x--;
y++;
if (x==y)
continue;
else
printf(“\n%d%d”,x,y);
}
```

Course Outcome 3 (CO3):

1. **A company needs a program to figure its weekly payroll. The input data, consisting of each employee’s identification number, pay rate, and hours worked, is in the file datafile.dat in secondary storage. The program should input the data for each employee, calculate the weekly wages, save the input information for each employee along with the weekly wages in a file, and display the total wages for the week on the screen, so that the payroll clerk can transfer the appropriate amount into the payroll account. Discuss the problem solving approach you would follow to develop the program.**
2. **Design an algorithm using factoring technique to establish all the primes in first n positive integers.**
3. In the Company Payroll Program, use means-ends analysis to develop the algorithm for calculating pay. What are the ends in the analysis? What information did we start with and what information did we want to end up with?

Course Outcome 4 (CO4):

1. Create a structure to specify data on students given: Roll number, Name, Department, Course, Year of Joining Assume there are not more than 450 students in the college,
   a. Write a function to print names of all students who joined in a particular year.
   b. Write a function to print the data of a student whose roll number is given.
2. A factory has 3 divisions and stocks 4 categories of products. An inventory table is updated for each division and for each product as they are received. There are three independent suppliers of products to the factory:
   a. Design a data format to represent each transaction.
   b. Write a program to take a transaction and update the inventory.
   c. If the cost per item is also given, write a program to calculate the inventory sales.
3. Create a structure called library to hold accession number, title of the book, author name, price of the book and flag indicating whether book is issued or not. Write code to list all the books by a given author and list the count of books in the library.

Course Outcome 5 (CO5):

1. Consider the following code segment:

   inti,j=25;
   *int*pi,pj=&j;*

   ……

   **pj=j+5;*

   *j=*pj+5;*

   pj=pj;

   **pi=i+j;*

   Each integer occupies 2 bytes of memory. The value assigned to i begin at the hexadecimal address F9C and the value assigned to j begins at address F9E. Compute the values of following:

   (a) &i (b)&j (c)pj (d) *pj (e)i (f) pi (g)*pi (h) (pi+2)
   (i) (*pi+2) (j) *(pi+2)

2. How many bytes in memory would be occupied by the following array of pointers to strings? How many bytes would be required to store the same strings, if they are stored in a two dimensional character array?
   Char *mess[] = {“DEPARTMENT”“OF”“INFORMATION”“TECHNOLOGY”};

   Can an array of pointers to strings be used to collect strings from the keyboard? Justify your answer.

3. Interpret the meaning of the following declarations involving pointers:
   in (*p[10]) (char a); int *(*p[10]) (char a); int *(*p[10]) (char *a);
   int *(*p) (char(*a)[]); int *p (char *a[]));

Course Outcome 6 (CO6):

1. Write a program to count the number of occurrences of any two vowels in succession in a line of text in a file. For Example, in the sentence “THIAGARAJAR COLLEGE OF ENGINEERING” such occurrences are EE,IA.
2. Write a program to read a file and count the number of characters, spaces, tabs and new lines present in it.
3. Write a program that will generate a data file containing the list of customers and their corresponding telephone numbers. Use a structure variable to store the name and telephone of each customer. Write code to determine the telephone number of a specified customer.

Course Outcome 7 (CO7):

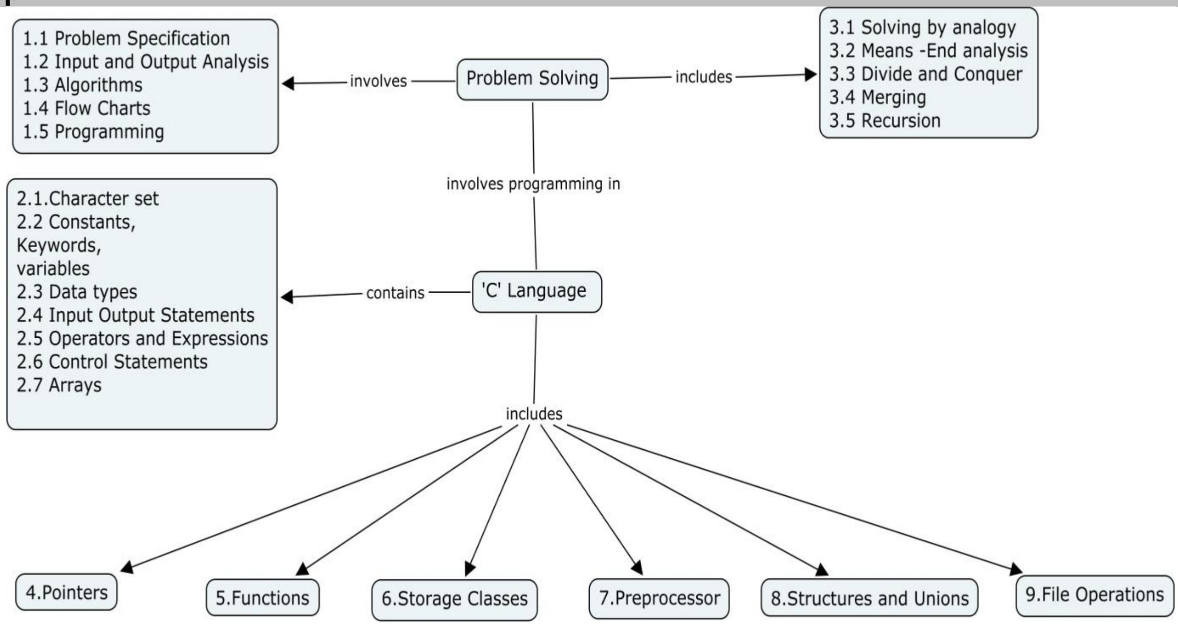
Design and Development of applications like

a. Encryptor/ Decryptor
b. Physics problem solver
c. Sudoku solver
d. Hospital management system
e. Random number generator
f. Electric circuit solver etc.
g. Scientific Calculator

Mini Project Details: (Team size: 5)

- Problem identification.
- Problem Analysis and Modular design.
- Develop algorithm/pseudo code and draw the flowchart – module wise individually.
- Develop programs module level, test and debug individually.
- Integrate the modular programs and present the results in a team.
- Document the above process as a report.

Concept Map



Syllabus

Introduction to Problem Solving – Problem Specification, input-output analysis, Algorithms – Design and Analysis, Implementation of Algorithms, Flowcharts, Programming – High level languages, language translators, syntax, semantics, compilation and execution, Debugging and Program verification.

Fundamentals of C - C Character set, Keywords, Constants and variables, Data types, Input and Output statements, Operators and Expressions, Operator Precedence, Type Conversion, Type casting. Control Statements, Branching and Looping

Problem Solving Techniques – Solving by analogy, Means-ends analysis, Divide and Conquer, Building Block Approach – Merging of Solutions.

Basic Algorithms – Exchange of variables, Counting, Summation of set of numbers, Generation of Fibonacci sequence, Number to character conversion.

Factoring Methods – Greatest Common Divisor of two integers, Generation of Prime numbers, raising number to larger power

Array Techniques – Counting of array elements, array reversal, partitioning an array, removal of duplicates in an array –Single and Multidimensional Arrays in C

Text Processing – Strings in C

Pointers – Declaration, Operations on Pointers, Pointers and one dimensional Arrays, Pointers and Multidimensional Arrays, Array of pointers, Dynamic Memory allocation.

Functions – Function Definition, Function Prototypes, Passing arguments to a function, Pointers to functions, Recursion.

Storage Classes – Automatic, External, Static and Register

C Preprocessor – Preprocessor directives, Macro Expansion, Conditional Compilation.

Structures and Unions – Definition, Processing a structure, Array of structures, Pointers to structures, Passing structures to Functions and Returning structure variables from functions, Self Referential Structures, Unions and Bit Fields. **Files** – Reading and writing a file, processing a data file, Unformatted Files and Binary Files.

Text Book

1. R.G.Dromey, "How to solve it by Computers", Pearson Education India , 2008.
2. Byron S.Gottfried, "Programming with C", McGraw Hill Education (India) Pvt Ltd, Third Edition, 2010.
3. Al Kelley and Ira Pohl, "A Book On C", Addison-Wesley , Fourth Edition, 1997.

Reference Books

4. Donald Ervin Knuth, "The Art of Computer Programming : Fundamental Algorithms" Volume I, Addison-Wesley, Third Edition, 2002.
5. YashavantKanetkar, "Let us C",BPB Publications, 13^{th} Edition, 2012
6. YashavantKanetkar, "Understanding Pointers in C", BPB Publications, 4^{th} Edition, 2009.

Course Contents and Lecture Schedule

Module No	Topic	Hours
1	**Introduction to Problem Solving**	
1.1 1.2	Problem Specification Input Output Analysis	1
1.3	Algorithm – Design and Analysis	1
1.4	Flow Charts	1
1.5	Programming – High level languages, language translators, syntax, semantics, compilation and execution	1
1.5	Debugging and Program verification.	1
2 2.1 2.2 2.3	**Fundamentals of C** Character set Constants, Variables and Key words Data types and Declarations	1
2.4	Input and Output Statements	1
2.5	**Operators and Expressions**	
2.5.1	Arithmetic, Relational, Logical and Conditional Operators, Bit wise Operators	1
2.5.2	Operator Precedence	1
2.5.3 2.5.4	Type Conversion Type Casting	1
2.6	**Control Statements**	
2.6.1 2.6.2 2.6.3	Branching Looping Break, Continue and Goto statements	1

2.7	Single and Multidimensional Arrays	2
2.8	Strings	1
3 3.1 3.2	**Problem Solving Techniques** Solving by analogy Means-ends analysis	1
3.3 3.4	Divide and Conquer Building Block Approach – Merging	1
3.5	Recursion	1
3.6 .1	**Basic Algorithms –** Exchange of variables, Counting, Summation of set of numbers, Generation of Fibonacci sequence, Number to character conversion.	2
3.6.2	**Factoring Methods –** Greatest Common Divisor of two integers, Generation of Prime numbers, raising number to larger power	1
3.6.3	**Array Techniques –** Counting of array elements, array reversal, partitioning an array, removal of duplicates in an array	1
3.6.4	**Text Processing** - Strings in C	1
4	**Pointers**	
4.1 4.2 4.3	Pointer to variables -Declaration and Operations Pointers and one dimensional Arrays Pointers to Strings	1
4.4 4.5	Pointers and Multi-dimensional Arrays Array of Pointers	1
4.6	Dynamic Memory allocation	1
5	**Functions**	
5.1 5.2	Function Definition and Function prototypes Passing Arguments to a function	1
5.3	Pointers to Functions	1
5.4	Recursion	1
6	**Storage Classes**	1
7	**C Preprocessor**	
7.1 7.2 7.3	Preprocessor Directives Macro Expansion Conditional Compilation	1
7.4	Multiple File Inclusions	1
8	**Structures and Unions**	
8.1 8.2 8.3	Definition and Processing of Structure Array of Structures Pointers to Structures	1
8.4 8.5	Passing Structures to Functions, Returning structure variables from functions Self-Referential Structures	1
8.6 8.7	Unions Bit Fields	1
9	**Files**	
9.1	Reading and writing to a file	1
9.2 9.3	Processing a Data file Unformatted Files and Binary files	1
	Total Lectures	**36**

Course Designers:

1. Mr. M.P.Ramkumar ramkumar@tce.edu

14CE380 COMPUTER AIDED DRAFTING LAB

Category	L	T	P	Credit
PC	0	0	2	1

Preamble

This laboratory course work is intended to provide students with opportunities to acquire knowledge and to develop skills in viewing and drawing the plan, section and elevation of the different types of the buildings manually as well as by using the drafting software AutoCAD. Manual drafting can be used to develop drafting skills where computer-aided design (CAD) software is not available.

Course Outcomes

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

		Expected Attainment Level in %	Expected Proficiency Level in grade
(CO1): Develop drafting skills in drawing sectional elevations of components of building manually	Apply	95	S
(CO2): Develop drafting skills in drawing plan, section and elevation of residential buildings manually	Apply	95	S
(CO3): Develop drafting skills in drawing plan, section and elevation of public buildings manually	Apply	95	S
(CO4): Develop drafting skills in drawing sectional elevations of components of building using AutoCAD software			
(CO5): Develop drafting skills in drawing plan, section and elevation of residential buildings using AutoCAD software	Apply	95	S
(CO6): Develop drafting skills in drawing plan, section and elevation of public buildings using AutoCAD software	Apply	95	S

ith Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO11	S	S	--	L	S	M	--	M	M	M	--	--	M	--
CO12	S	S	--	L	S	M	--	M	M	M	--	--	M	--
CO13	S	S	--	L	S	M	--	M	M	M	--	--	M	--
CO14	S	S	--	L	S	M	--	M	M	M	--	--	M	--
CO15	S	S	--	L	S	M	--	M	M	M	--	--	M	--
CO16	S	S	--	L	S	M	--	M	M	M	--	--	M	--

List of Experiments

Manual Drafting

1. Fully panelled door / Partly glazed and wooden panelled door – Elevation and cross section
2. Fully panelled window / Fully glazed window – Elevation and cross section
3. Dog legged staircase – Plan and Sectional Elevation
4. King post / Queen post wooden trusses
5. Single floor residential building - Plan, Section and Elevation
6. Storied residential building with Dog legged staircase - Plan, Section and Elevation
7. Framed office building - Plan, Section and Elevation
8. Residential building – Plan, Section and Elevation using given area

Drafting using AutoCAD software

1. Single floor residential building - Plan, Section and Elevation
2. Storied residential building with Dog legged staircase - Plan, Section and Elevation
3. Framed office building - Plan, Section and Elevation
4. Residential building – Plan, Section and Elevation using given area

Demonstration

1. 3D view of a single floor residential building

Reference Books

1. V.B. Sikka, “A Course in Civil Engineering Drawing”, 4th edition, S.K. Kataria & Sons, New Delhi, 2010.
2. M.G. Shah, C.M. Kale & S.Y.Patki, “Building Drawing with an Integrated Approach to Built Environment”, Tata McGraw Hill Publishing Co. Ltd. New Delhi, 2004.

3. George Omura, “ Mastering in AutoCAD 2002”- BPB Publications, New Delhi, 2002
4. Verma.B.P, "Civil Engineering Drawing and House Planning", Khanna Publishers, 1989.
5. “A Guide to building information modeling for Owners, Managers, Designers, Engineers, and Contractors”, John Wiley and Sons. Inc., 2008

IS Codes

1. IS 962:1967 Code of Practical for Architectural and Building Drawing
2. IS 1003:1977 Part I, II Specification for Timber Panelled and Glazed Shutters
3. IS 2191:1983 Part I, II Specification for Wooden Flush Door Shutters

Course Designers

Dr. S. Arulmary samciv@tce.edu
Dr. M.C. Sundarraja mcsciv@tce.edu

14CE390	SURVEY LAB II	Category	L	T	P	Credit
		PC	0	0	2	1

Preamble

Knowledge on basic survey methods (Survey Lab I) is essential in order to determine the distance and heights of the objects using stadia, tangential as well as trignometrical principle.

Prerequisite

Fundamentals of surveying and Survey Lab I

Course Outcomes

On the successful completion of the course, students will be able to:			Expected Attainment Level in%	Expected Proficiency Level in grade
(CO1)	Measure horizontal and vertical angles using Theodolite.	Apply	95	S
(CO2)	Locate the position of the object after finding the distance and heights using stadia method of survey	Apply	95	S
(CO3)	Find the position of points in the field by tangential method of surveying	Apply	95	S
(CO4)	Find the position of points in the field by tacheometric method of surveying	Apply	95	S
(CO5)	Set out a simple circular curve in the field.	Apply	95	S
(CO6)	Locate and plot the different features of the land by conducting total station survey	Apply	95	S

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO17	L	L	-	-	-	-	-	-	-	L	-	-	L	L
CO18	S	S	-	L	-	-	-	-	-	L	-	-	L	L
CO19	S	S	-	L	-	-	-	-	-	L	-	-	L	L
CO20	S	S	-	L	-	-	-	-	-	L	-	-	L	L
CO21	S	S	M	-	-	-	-	M	-	M	-	-	L	L
CO22	S	S	M	L	S	-	-	M	-	M	-	-	L	L

S- Strong; M-Medium; L-Low

List of Experiments:

1. Study of theodolite and measurement of horizontal angle by repetition method.
2. Measurement of horizontal angle by reiteration method.
3. Determine the distance and heights of the objects using Stadia tacheometric method.

4. Determine the distance and heights of the objects using tangential tacheometric method.
5. Find the gradient between two points using stadia and tangential tacheometric principle.
6. Find the distance and elevation of the inaccessible (single) object by single plane method.
7. Find the distance and elevation of the inaccessible (single) object by double plane method.
8. Find the elevation of the inaccessible (double) object by double plane method.
9. Determine the elevation of the given point using subtense bar.
10. Measurement of horizontal, sloping and vertical distances of the object using Total station.
11. Setting out a circular curve using Total Station.
12. Demo on instruments like GPS and Electronic Distance Meter.

Course Designers:

1.	Dr. K. Sudalaimani	ksciv@tce.edu
2.	Dr. T. Baskaran	tbciv@tce.edu

14CE4C2	CAPSTONE I

Category	L	T	P	Credit
PC	0	0	2	2

Preamble

The purpose of this course is to apply the concept of mathematics, science and engineering fundamentals and an engineering specialization to solve complex engineering problems.

Course Outcomes

	On the successful completion of the course, students will be able to		Expected Attainment level in %	Expected Proficiency Level in grade
CO1	Explain the basic concepts of core engineering courses in the programme	Understand	70	A
CO2	Explain the importance of mathematics and science in the programme and its correlation in core engineering courses of the programme	Understand	70	A
CO3	Solve basic problems in core engineering of the programme	Apply	70	A
CO4	Solve complex problems by applying the concepts of core engineering, mathematics and science course	Apply	70	A
CO5	Analyse complex problems in the core engineering courses of the programme	Analyze	70	A

Mapping with Programme Outcomes

S- Strong; M-Medium; L-Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2
CO1	M	L	-	-	-	-	-	-	-	-	-	L	L	-
CO2	M	L	-	-	-	-	-	-	-	-	-	L	L	-
CO3	S	M	L	L	L	-	-	-	M	-	-	L	M	L
CO4	S	S	L	L	M	-	-	-	M	-	-	L	M	L
CO5	S	S	M	L	S	-	-	-	M	-	-	L	S	L

Syllabus

Engineering Group1

Strength of Materials: Basics of statics- Simple Stresses and Strains- Principal stresses and strains-Shear Force and Bending Moment- Geometric properties of sections- Bending and shear stresses

Surveying: Chain surveying-Compass surveying-Plane table surveying-Levelling-Areas and volumes-Theodolite survey-Curves- Modern methods of surveying

Geology: General geology-Seismology-Minerals and rocks-Structural geology-Engineering Geology

Engineering Group 2

Building Materials and Technology: Orientation in buildings-Materials for construction-Technologies for construction-Construction tools and Machinery.

Mechanics of Solids: Axial and bending stresses- Torsion of circular shafts- Slope and deflection of beams- Analysis of Trusses- Moving Loads and Influence Line- Cables, stiffening girders and arches

Fluid Mechanics: Fluid statics-Pressure measurements-Fluid kinematics-Fluid dynamics-Flow measurements in pipes-Boundary layer theory-Flow through pipes.

Engineering Group 3

Water Supply Engineering: Demand estimation-Identification of sources, intakes and transport of water-Quality assessment-Treatment of water-Water distribution.

Concrete Technology: Concrete making Materials- Cement-Fine aggregate-Coarse aggregate-Water-Admixtures- Concrete Production & Fresh concrete- Concrete mix design- Engineering properties of concrete- Dimensional stability and Durability of concrete- Special concretes

Assessment Pattern

(Common to B.E./B.Tech Programmes)

Test 1: Engineering Group 1 (60 Marks), Duration : 90 Minutes

Objective Type Questions : 30 (10 Questions from each group)

Fill up the blanks : 30 (10 Questions from each group)

Test 2: Engineering Group 2, Engineering Group 3 ; Duration : 90 Minutes (60 Marks)

Objective Type Questions : 30 (10 Questions from each group)

Fill up the blanks : 30 (10 Questions from each group)

Test 3: Comprehensive (60 Marks); Duration : 90 Minutes

Objective Type Questions : 30 (5 Questions from each group)

Fill up the blanks : 30 (5 Questions from each group)

Test	Marks Obtained	Converted to
Test1	60 Marks (Max)	20 Marks (Max)
Test 2	60 Marks (Max)	20 Marks (Max)
Test 3	60 Marks (Max)	60 Marks (Max)
		100 Marks (Max)

No re-test will be conducted at any circumstances

Course Designers:

1. Engineering faculty 1: Dr.T.Baskaran
2. Engineering Faculty 2: Dr.D.Brindha

	Category	L	T	P	Credit
14CE410 MATHEMATICS - IV	BS	2	2	0	3

Preamble

The theory of probability is a unified mathematical theory with applications to many natural sciences; physics, engineering, medicine, economy, etc., all benefit from probabilistic computations. The main mission of the Indian Statistical System shall be to provide within the decentralized structure of the system reliable, timely and credible social and economic statistics to assist decision making within and outside the Government, stimulate research and promote informed debate relating to conditions affecting people's life. Based on this, the course aims at giving adequate exposure in basic concepts of probability, probability distributions, regression and correlation, test of hypothesis and design of experiments.

Course Outcomes

Course Outcomes	Bloom's level	Expected attainment level (%)	Expected Proficiency Level (grade)
CO1 : Infer axioms of probability, elementary theorems, conditional probability, discrete and continuous random variables	Understand	70	B
CO2: Apply the concept of expectation and moment generating functions of discrete and continuous distributions in Engineering problems.	Apply	60	B
CO3 Identify the correlation, regression in linear forms.	Apply	70	B
CO4: Apply the concept of least square method in fitting linear and non linear regression curves.	Apply	65	B
CO5: Explain the test of hypothesis for small and large samples by using various tests like t-test, F-test, z-test and chi-square test	Understand	70	B
CO6: Apply the concept of ANOVA to measure the effect of extraneous variables.	Apply	60	C

Mapping with Program Outcomes

COs	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	S	M	S										S	S
CO2	S	M	S										S	M
CO3.	S	S	S										S	S
CO4.	S	S	M										S	
CO5.	M	M	M										S	S
CO6.	S	S	S	S										

Correlation: S-Strong; M-Medium; - L- Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	0
Understand	30	30	30	30
Apply	60	60	60	70
Analyse	0	0	0	0
Evaluate	**0**	**0**	**0**	**0**
Create	**0**	**0**	**0**	**0**

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. A and B toss affair coin alternately with the understanding that the one who obtains the head first wins. If A starts, what is his chance of winning?
2. Define conditional probability
3. A box contains 7 red and 13 blue balls. Two balls are selected at random and are discarded without their colors being seen. If a third ball is drawn randomly and observed to be red, estimate the probability that both of the discarded balls were blue.

Course Outcome 2 (CO2):

1. Predict the value of 'a' if $P(X = x) = a\,(2/3)^{x}$; $x = 1,2,3\ldots\ldots$

2. The distribution function of a Random variable X is given by F(x) = 1 – (1+ x) e^{-x} ; x ≥ 0. Find the density function and mean.

3. Estimate the moment generating function of the random variable X given pdf

f(x) = $2e^{-2x}$; x > 0

Course Outcome 3 (CO3):

1. Compute $R_{1.23}$ if r_{12}=0.77; r_{13}=0.72; r_{23}=0.52.
2. Differentiate between correlation and regression of variables
3. Coefficient of correlation between x and y is 0.48. Their covariance is 36. The variance is 16. Find the standard deviation of y.

Course Outcome 4 (CO4):

1. Fit a parabola for a following data

X: 1	2	3	4	5	6	7	8	9	10
Y: 2	6	7	8	10	11	11	10	9	7

2. Determine the plan of regression of Y on X1 and X2 for the following data:

Y :	90	72	54	42	30	12
X1:	3	5	6	8	12	14
X2:	16	10	7	4	3	2

3. In a distribution $\sigma_1 = 2, \sigma_2 = 3, \sigma_3 = 3, r_{12} = 0.7, r_{23} = 0.5, r_{31} = 0.5$ Find

(i) $r_{23.1} (ii) R_{1.23} (iii) b_{12.3}, b_{13.2} (iv) \sigma_{1.23}$

Course Outcome 5 (CO 5):

1. Explain Null hypothesis.
2. The nicotine contents in two samples of tobacco are given below:

Sample 1:	21	24	25	26	27	-
Sample 2:	22	27	28	30	31	36

Can you demonstrate that the two samples came from the same normal population?

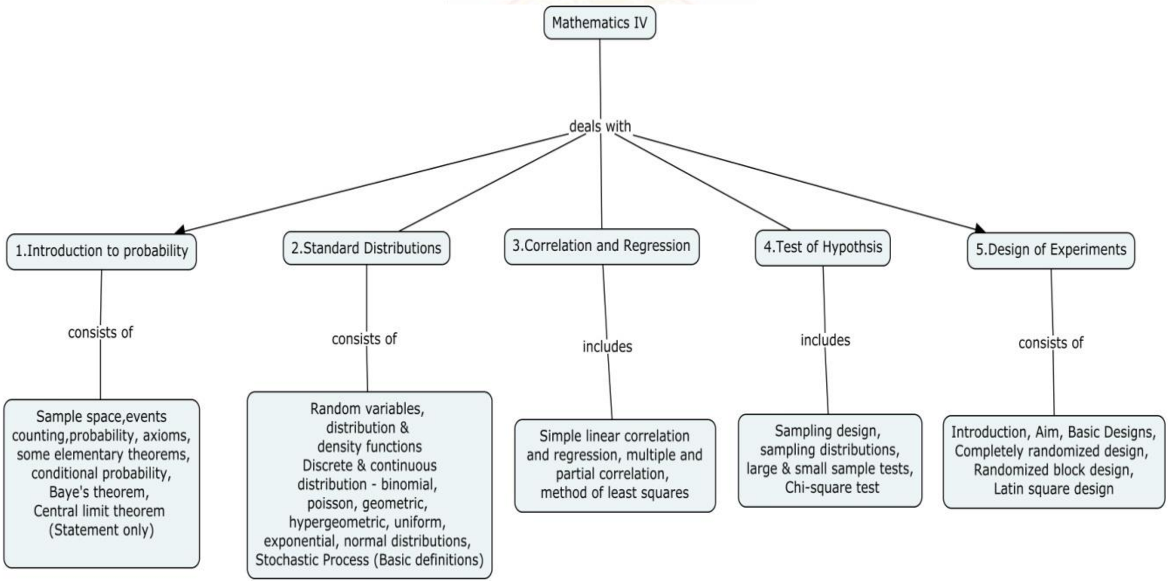
3. Twenty people were attacked by a disease and only 18 survived. Will you reject the hypothesis that the survival rate if attacked by the disease is 85% in favor to the hypothesis that it is more at 5% level?

Course Outcome 6 (CO 6):

1. Model the format of two-way classification ANOVA table
2. Compare and contrast Randomized Block Design and Latin Square Design
3. Analyze the variance in the following |Latin Square:

B 20	C17	D25	A34
A23	D21	C15	B24
D24	A26	B21	C19
C26	B23	A27	D22

Concept Map



Syllabus

Introduction to Probability: Sample spaces and events, counting, probability, the Axioms of probability, Some elementary theorems, Conditional probability, total probability, Baye's theorem, Central limit theorem (only statement) **Standard Distributions:** Random variables, Discrete, continuous Random variables, Distribution and density functions, binomial, Poisson, geometric, hyper geometric, uniform, exponential and normal distributions, Stochastic process (basic definitions) **Correlation and Regression:** Simple linear correlation and regression, multiple and partial Correlation Coefficients, method of least squares, plane of regression . **Test of Hypothesis:** Sampling design, sampling distributions, , Large and small sample tests, Test for (1)Proportion (2) Difference between two proportions, (3)means and (4) variances for large and small samples, Tests of goodness of fit and independence of attributes. **Design of Experiments**: Introduction, aim, basic designs of experiments, completely randomized design, randomized block design, latin square design.

Text Books

1. S.C.Gupta, V.K.Kapoor, " Fundamentals of Mathematical Statistics", Tenth Edition, Sultan Chand & Sons, New Delhi, 2002
2. T.Veerarajan, " Probability and Statistics", Second edition, Tata McGraw-Hill Education, New Delhi, 2008

Reference Books

1. Jack R.Benjamin and C.Allin Cornell, "Probability, Statistics & Decisions for Civil Engineers", First revised edition, Dover publications, Mineola, New York,2014
2. J.N.Sharma, J.K.Goel, "Mathematical Statistics", Seventh Edition, Krishna Prakasham Mandir, Meerut, 1998.
3. Miller Freund's, "Probability and Statistics for Engineers", Eighth edition, PHI Learning Private Limited, Delhi, 2003

Course contents and Lecture Schedule

S.No	Topics	No. of Lectures
1	**Introduction to probability**	
1.1	Sample spaces and events, counting, probability, the Axioms of probability	1

1.2	Some elementary theorems, Conditional probability	1
	Tutorial	2
1.3	Total probability, Baye's theorem ,central limit theorem	2
	Tutorial	2
2	**Standard distributions**	
2.1	Random Variables, Discrete and Continuous RVs	2
2.2	Distribution and Density functions	1
2.3	Binomial , Poisson distributions	1
2.4	Geometric and Hypergeometric Distributions	1
	Tutorial	2
2.5	Uniform, exponential Distributions	1
2.6	Normal distribution , stochastic process(definitions)	1
	Tutorial	3
3	**Correlation and regression**	
3.1	Simple linear correlation and regression	1
	Tutorial	2
3.2	Multiple and partial correlation coefficients	1
3.3	Method of least squares	2
3.4	Plane of regression	1
	Tutorial	3
4	**Test of Hypothesis**	
4.1	Sampling design and Sampling Distributions	1
4.2	Large Sample Tests- Z test for proportion, mean	2
	Tutorial	3
4.3	Small sample Tests- t test, F test	1
4.4	Chi-square tests	1
	Tutorial	3
5	**Design of experiments**	
5.1	Introduction , aim ,basic designs of experiments	1

5.2	Completely randomized design, randomized block disign	1
	Tutorial	2
5.3	.Latin square design	1
	Tutorial	2
	Total Hours	48

Course Designers

1. Mr. P. Subramanian psmat@tce.edu
2. Dr. M. Sivanandha sarawathi sivanandha@tce.edu
3. Dr. N. Chitra ncmat@tce.edu

14CE420	STRUCTURAL ANALYSIS	Category	L	T	P	Credit
		PC	2	2	0	3

Preamble

This course offers the various methods of analysis for indeterminate beams and portal frames. It aims at determination of end moments and constructing shear force and bending moment diagrams for the beams and frames. Also, ILD for indeterminate beams will be dealt with.

Prerequisite

Fundamentals of strength of materials and mechanics of solids.

Course Outcomes

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

			Expected Attainment level in %	Expected Proficiency Level in grade
CO1	Construct ILD for indeterminate beams	Apply	70	A
CO2	Analyse beams and frames by strain energy method	Apply	70	A
CO3	Analyse continuous beams, fixed beams and propped cantilever using theorem of three moments	Apply	70	A
CO4	Analyse beams and frames by slope deflection method	Apply	70	A
CO5	Analyse beams and frames by moment distribution method	Apply	70	A
CO6	Analyse beams and frames by matrix stiffness method	Apply	70	A

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2
CO1	S	S	M	-	-	L	-	-	-	M	-	S	M	L

CO2	M	M	-	-	-	-	-	-	-	-	L	-	M	L
CO3	S	S	-	-	-	-	-	-	-	-	-	S	M	L
CO4	S	S	-	M	-	M	-	-	-	-	-	S	M	M
CO5	S	S	-	-	M	L	M	-	M	S	-	S	M	M
CO6	S	S	M	-	M	L	M	-	-	-	-	S	M	M

Mapping with Programme Outcomes

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	**2**	**3**	
Remember	10	10	10	10
Understand	10	10	10	10
Apply	60	60	60	60
Analyze	20	20	20	20
Evaluate	--	--	--	--
Create	--	--	--	--

Course Level Assessment Question

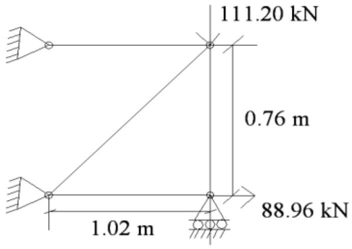
Course Outcome 1 (CO1):

10. **State Muller Breslau's principle**
11. **Write the significance of influence line diagrams.**
12. **Express the equation for finding influence line diagram ordinate for reaction of a propped cantilever beam.**
13. **Sketch the shape of influence line diagram for shear force at any section of a two span continuous beam of two equal spans**
14. **Draw the influence line diagram for reaction at A and B of a two span continuous beam ABC with simply supported ends having length AB=BC = 6m Compute ILD ordinates at 2m intervals**
15. **Derive the influence line diagram for the prop reaction at B of a propped cantilever. Using the influence diagram, determine the prop reaction if the beam has a span of 8m and subjected to three point loads of 15kN, 10kN and 20kN at 2m,4m and 6.5m from the propped end**

4. Define the term strain energy

Course Outcome 2 (CO2):

5. State theorem of minimum strain energy as applied to indeterminate beams. Also, write the governing equation.
6. A propped cantilever beam AB of span 6m is subjected to a uniformly distributed load of 15kN/m over the entire span and point loads of 10kN and 15kN at 2m and 4m respectively from the propped end B. Determine the prop reaction using strain energy method.
7. A propped cantilever beam AB of span 6m is subjected to a uniformly distributed load of 15kN/m over the entire span and a point load of 10kN at 2m from the propped end B. Determine the prop reaction using strain energy method.
8. A two span continuous beam of equal spans is subjected to a uniformly distributed load of 20kN/m over the entire length of both spans. Determine the reaction at mid support by strain energy method.
9. Find the force in the members of the truss loaded as shown in Fig.1. Use strain energy method. A and E same for all members



Course Outcome 3 (CO3):

16. **Write the application of Clapeyron's theorem of three moments.**
17. **Outline area and c.g distances of free body diagram of any two loading conditions**
18. **A continuous beam ABC fixed at end A and continuous over supports B and C. The span AB=8m carries a uniformly distributed load of 6kN/m over the entire span. The span BC=5m carries a non-central concentrated load of 15kN acting at a distance of 3m from support B. Analyse the beam and draw bending moment diagram using theorem of three moments. (EI is constant)**

19. **A continuous beam ABCD simply supported at ends A and D and continuous over supports B and C. The span AB=5m carries a non central concentrated load of 15kN at 2m from A. The span BC=4m carries a uniformly distributed load of 6kN/m over the entire span. The span CD=5m carries a central concentrated load of 10kN. Analyse the beam and draw bending moment diagram.Use theorem of three moments. (EI is constant)**

Course Outcome 4(CO4):

20. **Brief slope deflection equation and mention the use of conjugate beam method in**

    deriving slope deflection equation.

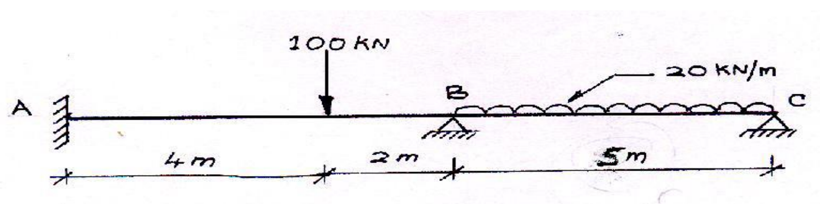
21. **List out the reasons for the sway of portal frame with neat sketches**
22. **Write the slope deflection equation in case of frames with side sway explaining the sign convention followed**
23. **A continuous beam ABCD of 14 metres span fixed at ends A and D and continuous over supports B and C. The span AB=5m carries a central load of 10kN.The span BC=4m carries a uniformly distributed load of 4kN/m over the span BC. The span CD=5m carries a central load of 8kN. Analyse the beam using slope deflection method and draw the bending moment diagram. (EI is constant)**

Course Outcome 5 (CO5):

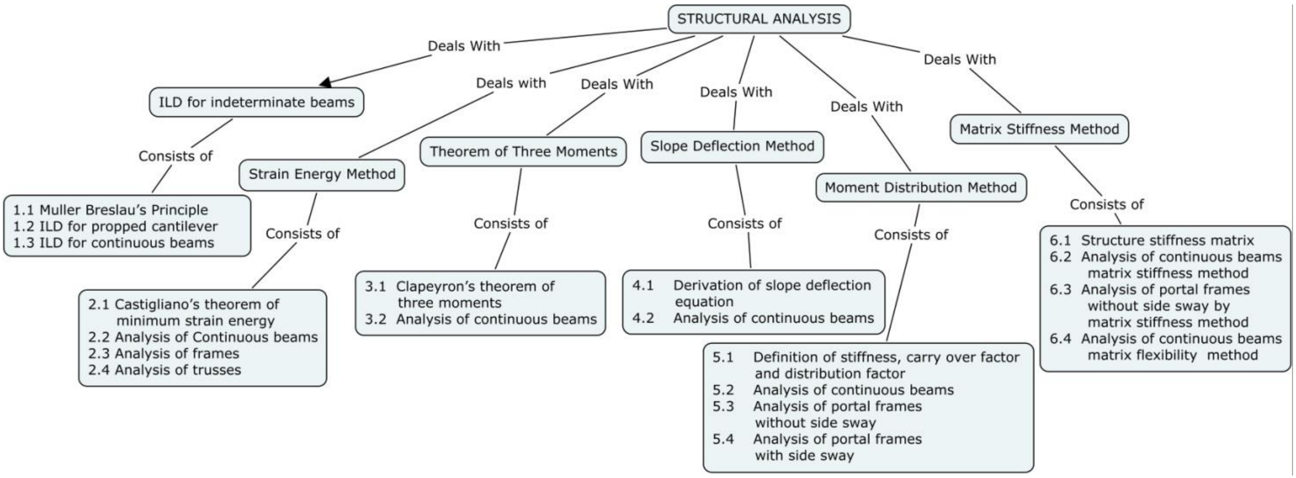
24. **Define the terms stiffness and distribution factor**
25. **Write the advantage of moment distribution method over slope deflection method**
26. **Express fixed end moments due to applied clockwise couple in a beam of span 'l'.**
27. **Calculate the end moments of a three span continuous beam ABCD of span AB=4.0m loaded with a uniformly distributed load of 20kN/m over the entire span, span BC=5.0m loaded with a point load of 40kN acting at 3.0m from B and span CD=5.0m loaded with 60kN acting at 2.0m from C with fixed ends at A and D. Use Moment distribution method.**
28. **Analyze a rectangular portal frame ABCD with fixed end at A and hinged end at D having dimensions AB=6m, DC=4.0m, and the horizontal member BC=5.0m. The frame is loaded with a concentrated load of 60kN acting at a distance of 3.0 m from the rigid joint B on the member BC and a uniformly distributed load of 20kN/m over the entire length of the vertical member DC. Use Moment distribution method**

Course Outcome 6 (CO6):

1. How would you obtain structure stiffness matrix?
2. Write the general element stiffness matrix of a two span continuous beam.
3. A continuous beam ABC fixed at end A, continuous over support B and freely supported at C. The span AB=6m carries a uniformly distributed load of 15kN/m over the entire span. The span BC=5m carries a non-central concentrated load of 20kN acting at a distance of 3m from support B. Analyse the beam by matrix stiffness method. (EI is constant). Draw the shear force and bending moment diagrams.
4. **A portal frame of spans AB = 3m, BC = 4.5m and CD = 3m is subjected to a uniformly distributed load of 15kN/m over the entire span of BC. Analyse by matrix stiffness method and draw the bending moment diagram. MI of spans AB and CD : I and that of BC is 2I**
5. **Analyse the continuous beam shown in Fig. By matrix flexibility method**



Concept Map



Syllabus

ILD for indeterminate beams: Muller Breslau's principle – Influence line diagrams for propped cantilever and continuous beams **Strain Energy Method:** Introduction – Castigliano's theorem of minimum strain energy – Analysis of beams ,frames and trusses. **Theorem of Three Moments:** Clapeyron's theorem of three moments - Analysis of continuous beams. **Slope Deflection Method:** Derivation of slope deflection equation – Analysis of continuous beams. **Moment Distribution Method:** Stiffness – carry over factor – distribution factor - Analysis of continuous beams – Analysis of portal frames with and without side sway (single storey and single bay). **Matrix Methods:** Structure Stiffness Matrix – Analysis of continuous beams – Analysis of portal frames without side sway (single storey and single bay) by matrix stiffness method – Analysis of continuous beams by matrix flexibility method.

Text Book

3. Punmia, B.C., Arun Kumar, Ashok Kumar., Theory of structures, Laxmi Publications, New Delhi, 2014.
4. Devdas Menon., Structural Analysis,Alpha Science International, 2008.

Reference Books

7. Wang.,C.K., " Indeterminate Structures" McGraw Hill Book Co., Newyork, 1994
8. Pandit G.S and Gupta S.P., " Structural Analysis – A Matrix Approach" Tata McGraw-Hill Publishing Ltd. New Delhi, 2007
9. Reddy,C.S., "Basic Structural Analysis", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2010
10. Junnarkar, S.B. & Shah, H.J.., Mechanics of structures, vol.I, II, Charotar Publishing House, India, 2000
11. Thandavamoorthy, ''Analysis of Structures", Oxford &IBH Publishers, New Delhi.2008
12. Jindal,R.L, "Indeterminate Sructures", S.Chand and Company Ltd., New Delhi 2000

13. NPTEL materials (http://nptel.ac.in/courses/105106050)

Course Content

Module No.	Topic	No. Of Lectures
1.0	**ILD for indeterminate beams**	
1.1	Muller Breslau's Principle	1
1.2	Influence line diagram for propped cantilever	1
	Tutorial	2
1.3	Influence line diagram for continuous beams	2
	Tutorial	2
2.0	**Strain Energy Method**	
2.1	Castigliano's theorem of minimum strain energy	1
2.2	Analysis of continuous beams	1
	Tutorial	2
2.3	Analysis of frames	1
	Tutorial	1
2.4	Analysis of trusses	1
	Tutorial	1
3.0	**Theorem of three moments**	
3.1	Clapeyron's theorem of three moments	1
3.2	Analysis of continuous beams	1
	Tutorial	2
4.0	**Slope Deflection Method**	
4.1	Derivation of slope deflection equation	1
4.2	Analysis of continuous beams	1
	Tutorial	2
5.0	**Moment Distribution Method**	
5.1	Definition of stiffness, carry over factor and distribution factor	1
5.2	Analysis of continuous beams	1
	Tutorial	2
5.3	Analysis of portal frames without side sway	1
5.4	Analysis of portal frames with side sway	2
	Tutorial	3
6.0	**Matrix Methods**	
6.1	Structure stiffness matrix	1
6.2	Analysis of continuous beams by matrix stiffness method	2
	Tutorial	3
6.3	Analysis of portal frames without side sway by matrix stiffness method	2
	Tutorial	2

Module No.	Topic	No. Of Lectures
6.4	Analysis of continuous beams by matrix flexibility method	2
	Tutorial	2
Total hours	**(24 Theory + 24 Tutorials)**	**48**

Course Designers:

1. Dr. B. Sivagurunathan sivagurunathan@tce.edu
2. Dr. S. Nagan nagan_civil@tce.edu

14CE430 HYDRAULICS AND HYDRAULIC MACHINERY

Category	L	T	P	Credit
PC	3	0	0	3

Preamble: This course aims at an experimental way of studying the fluid flow, which deals with measurement, design and behavior of flow in open channels. Further, it also involves Dimensional analysis, model testing and design of hydraulic machines at an optimum cost.

Prerequisite

Engineering Mathematics, Physics and Fluid Mechanics

Course Outcomes

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

		Expected Attainment Level in %	Expected Proficiency Level in grade
(CO1) Explain the various types of open channels and their flows	Understand	70	A
(CO2) Design the various types of most efficient channel sections	Apply	70	A
(CO3) Apply the principles of Dimensional Analysis and Model Analysis in hydraulic engineering problems.	Apply	70	A
(CO4) Compute the forces exerted by the jet of water on fixed and moving plates.	Apply	70	A
(CO5) Design and study the performance of various types of hydraulic turbines.	Apply	70	A
(CO6) Design and study the performance of various types of pumps.	Apply	70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO15	L	L	L	L	-	-	-	-	-	-	-	-	L	-
CO16	S	S	S	S	-	-	-	M	-	-	-	M	M	L
CO3	S	S	S	S	-	-	-	-	-	-	-	-	M	L
CO4	S	S	L	L	-	L	-	-	-	-	-	-	M	L
CO5	S	S	S	S	-	L	L	M	-	-	-	-	M	L
CO6 .	S	S	S	S	-	L	L	M	-	-	-	-	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	20	20	20	20
Apply	60	60	60	60
Analyse	---	---	---	---
Evaluate	---	---	---	---
Create	---	---	---	---

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is an open channel flow?
2. Define the following terms
    i. Hydraulic radius (ii). Wetted Perimeter and (iii) Slope of the bed
3. Differentiate between steady and unsteady flow in a channel.
4. Why is a bed slope provided for an open channel?
5. List the advantages of Hydraulic jump.

Course Outcome 2 (CO2):

1. A rectangular channel is 7m wide and 1.8m deep. If the bed of the channel is laid at a slope of 1in 6000, calculate the velocity of flow and discharge. Use Chezy's equation and assume C= 50
2. Determine the dimensions of the most economical trapezoidal earth-lined channel to carry 15m^3/s at a slope of 1in 2400. Apply Manning's equation and assume n = 0.020
3. The discharge of water through a rectangular channel of width 7m, is 16m^3/s when the depth of flow of water is 1.2m, Calculate (i) Specific energy of the flowing water, (ii) critical depth and critical velocity and (iii) value of minimum specific energy.
4. A rectangular channel 2m wide has a discharge of 0.25m^3/s, which is measured by a right angled V notch. Find the position of the apex of the notch from the bed of the channel if the maximum depth of water is not to exceed 1.3m. Assume Cd = 0.62
5. A sewer pipe is to be laid at a slope of 1 in 7500 to carry a maximum discharge of 1m^3/s, when the depth of water is 75% of the vertical diameter. Compute the diameter of this pipe, if the value of Manning's N is 0.025

Course Outcome 3 (CO3):

1. Briefly explain, (i) Geometric similarity, (ii)Kinematic similarity and (iii) Dynamic similarity
2. Explain Rayleigh's method of obtaining relation between a given set of variables influencing a phenomenon.
3. The frictional torque T of a disc of diameter D rotating at a speed N in a fluid of viscosity μ and density ρ in a turbulent flow is given by
    $T = D^5N^2 \rho \varphi [\mu/D^2N \rho]$ Prove this by the method of dimension.

4. The discharge Q of a centrifugal pump depends upon the mass density of the fluid ρ, the speed of the pump N, the diameter of the impeller D, the manometric head H,

viscosity of the fluid μ and acceleration due to gravity g. Obtain an expression for Q, using Buckingham's π theorem.

5. A 7.0 m high and 10 m long spillway discharges 90 m^3/s discharge under a head of 2m. If 1:10 scale model of this spillway is to be constructed, determine model dimensions, head over spillway model and the model discharge. If model experiences a force of 7200N, determine force on the prototype.

Course Outcome 4 (CO4):

1. Derive an expression for the force exerted by a jet of water on a fixed vertical plate in the direction of the jet.
2. Draw the velocity triangles for unsymmetrical moving curved vane when the jet strikes tangentially at one of its tip.
3. A jet of water 50mm in a diameter, issues with a velocity of 10m/s and impinges on a stationary flat plate which destroys its forward motion. Calculate the force exerted by the jet on the plate and the work done.
4. A jet of water having velocity of 30m/s strikes a curved vane which is moving with a velocity of 15m/s. The jet makes an angle of 30^0 with the direction of motion of vane at inlet and leaves at an angle of 120^0 to the direction of motion at outlet. Draw the velocity triangles at inlet and outlet. Also calculate (i) van angles at inlet and outlet (θ,Φ) and (ii) work done per second on the vane by the jet.

Course Outcome 5 (CO5):

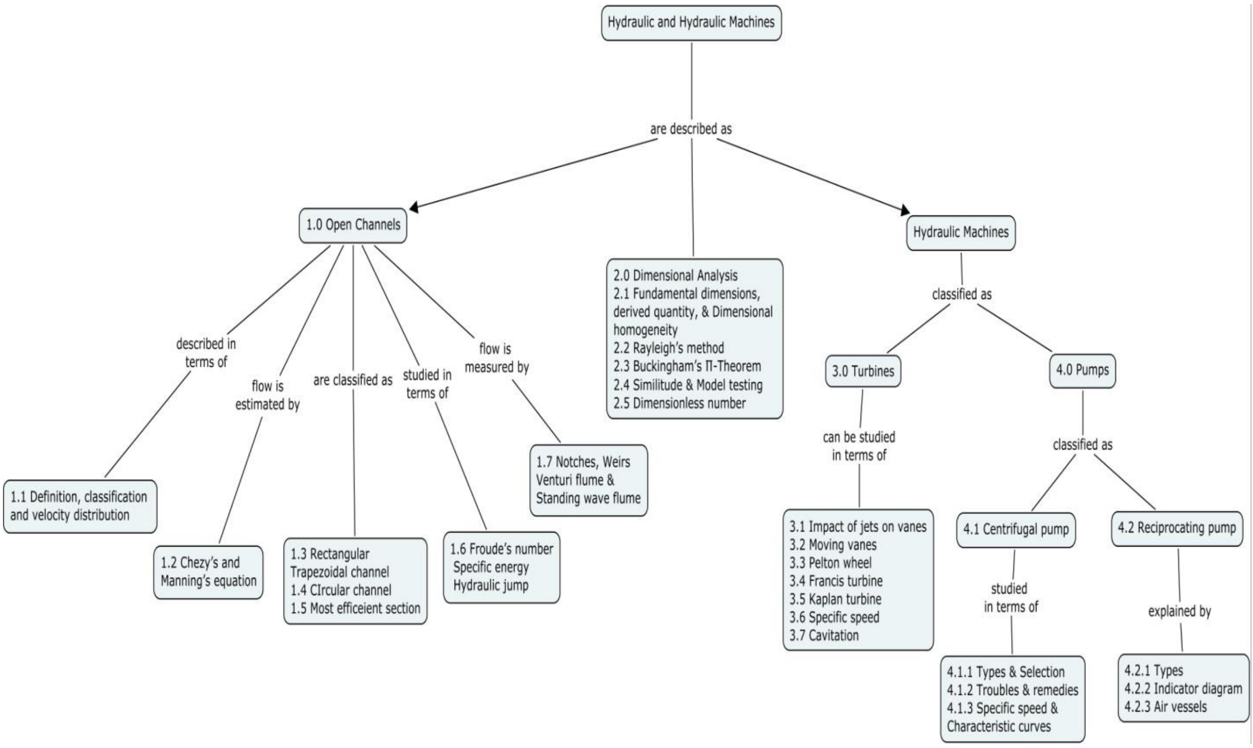
1. Differentiate radial flow and axial flow turbines.
2. Define specific speed of turbine.
3. Design a Pelton wheel for a head of 50m when running at 250 rpm. The Pelton wheel develops 90kW shaft power. The velocity of buckets =0.45 times the velocity of jet, overall efficiency is 85% and co-efficient velocity is 0.98
4. An inward radial flow reaction turbine works at 500rpm under a head of 100m. The diameter of turbine at inlet is 1.0m and flow area is $0.35m^2$. The angles made by absolute velocity and relative velocities at inlet are 15^0 and 60^0 respectively with the tangential velocity. Determine (i) Volume rate of flow, (ii) Power developed and (iii) Hydraulic efficiency of turbine.
5. A turbine is to operate under a head of 30m at 300 r.p.m. The discharge is $10m^3/s$. If the efficiency is 90% determine (i) Specific speed of the turbine, (ii) Power generated and (iii) type of the turbine.

Course Outcome 6 (CO6):

1. What is priming?
2. Mention the importance of connecting the pumps in series and in parallel?
3. Define slip of a reciprocating pump, at what condition the negative slip occur.
4. A centrifugal pump having outer diameter equal to two times the inner diameter and running at 1000 rpm, works against a total head of 40m. The velocity of flow through the impeller is constant and equal to 2.5 m/s. The vanes are curved back at an angle of 40^o at outlet. If the outer diameter of the impeller is 600mm and width at outlet is 50mm, determine (i) Discharge through the pump, (ii) Vane angle at inlet (θ), (ii) Work done by impeller on water per second and (iii) Manometric efficiency.
5. The cylinder bore diameter of a single acting reciprocating pump is 200mm and its stroke is 400mm. The pump runs at 50 rpm and lifts water through a height of 25m. The delivery pipe is 22m long and 100mm in diameter. Find the theoretical

discharge and theoretical power required to run the pump. If the actual discharge is 4.2 litres/s. Find the percentage of slip. Also determine the acceleration head at the beginning and middle of the delivery stroke.

Concept Map



Syllabus:

Open channel flow: Definition, classification, and velocity distribution in open channels. Chezy's and Manning's equation. Flow through rectangular, Trapezoidal and Circular channels. Hydraulically most efficient channel section. Froude's number, Specific energy diagram, Hydraulic jump, Notches, Weirs, Venturi flume and Standing wave flume. **Dimensional Analysis:** Fundamental dimensions and derived quantity, Dimensional homogeneity, Rayleigh's method and Buckingham's Pi-Theorem, Similitude, Model testing, Dimensionless number. **Impact of jets:** Impact of jets on vanes. **Water turbines:** Historical development of turbines and classification, Pelton wheel, Francis turbine, Kaplan turbine, specific speed and Cavitation. **Pumps:** Types of pumps, Selection of pumps, Troubles and remedies, Multistage pumps, Characteristics curves, Specific speed. Single and double acting reciprocating pump, Multi-cylinder pump, Indicator diagram, Slip and Air vessels. Special Pumps – Jet, Compressible and Submersible pumps.

Text Book

3. Modi P.N and Seth S.M, "Hydraulics and Fluid Mechanics Including Hydraulic Machines" Standard Book House" New Delhi, 20th Edition 2015.

Reference Books

1. Bansal R.K, " Fluid Mechanics and Hydraulic Machines" Laxmi Publications, New Delhi, 2015.
2. Rajput. R.K, " A Text book of Fluid Mechanics and Hydraulic Machines", S.Chand and Company, New Delhi,2011.
3. Subramanya K, "Flow in open channels", Tata McGraw-Hill Publishing Company, 2009.
4. Ramamrutham S and Narayanan R "Hydraulics, Fluid Mechanics and Fluid Machines", DhanpatRai Publishing Co (P) Ltd, New Delhi 2006.
5. Robert W.Fox and Alan T. Mc Donald, "Introduction to Fluid Mechanics" Seventh Edition, John Willey & sons, New York, 2009.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Open Channel Flow**	
1.1	Introduction to open channel flow, Definition of open channel flow, uniform flow,steady flow, unsteady flow, GVF,RVF	1
1.2	Chezy's equation & Manning's equation,	1
1.3	Problems on rectangular and trapezoidal channel section	2
1.4	Circular channel section and Problems	1
1.5	Definition for Most economical section, Most economical section condition for rectangular section and Problems.	1
1.6	Most economical section condition for trapezoidal section and Problems.	1
1.7	Most economical section condition for circular section	1
1.8	Definition of Froude's number and Reynold's number , Definition of specific energy, specific energy diagram, critical depth, and critical velocity	1
1.9	Expression for depth of hydraulic jump,& Expression for loss of energy due to hydraulic jump, Problems on hydraulic jumps	1
1.10	Flow measurement by notches and weirs & problems	1
1.11	Venturiflume& Standing wave flume	1
2	**Dimensional Analysis**	
2.1	Introduction to dimensional analysis, fundamental dimensions, derived quantity, dimensional homogeneity and problems.	1

Module No.	Topic	No. of Lectures
2.2	Rayleigh's method and problems	2
2.3	Buckingham's Pi theorem and problems	2
2.4	Similitude and model testing	1
2.5	Dimensionless numbers and its application	2
3	**Impact of Jets**	
3.1	Definition of impact of jet and stationary flat vanes	1
3.2	Problems on Stationary symmetrical & unsymmetrical curved vanes	2
4	**Hydraulic Turbines**	
4.1	Introduction to water turbine and its classification, Pelton wheel & problems	2
4.2	Francis turbine working principle and problems	2
4.3	Kaplan turbine working principle and problems	1
4.4	Specific speed and cavitation in turbines	1
5	**Pumps**	
5.1	Introduction to centrifugal pump, & Description of working principles	1
5.2	Troubles and remedies in centrifugal pumps	1
5.3	Performance characteristics, specific speed of centrifugal pumps, and Similarity and selection of centrifugal pumps	1
5.4	Introduction to reciprocating pump, single acting and double acting pump and slip	1
5.5	Indicator diagrams	1
5.6	Air vessels and acceleration head and power required	1
5.7	Jet, Compressor and Submersible pumps	1
	Total Hours	**36**

Course Designers

1. M.Ramasamy mrciv@tce.edu
2. Dr.T.Baskaran tbciv@tce.edu

14CE450	ENGINEERING DESIGN

Category	L	T	P	Credit
PC	1	0	2	3

Common for B.E./B.Tech Degree Programmes
(Course Codes: 14ME420, 14EE450, 14EC450, 14IT450, 14CS340, 14MT420)

Preamble

Engineering design is normally taught, not as a unified course in India. The courses like Product design, Machine design, Electrical machine design and transformer design, Control system design and Communication system design are tailored to specific topics there were many new approaches developed over a period of time. There is a need to discuss a unified approach of design in a course.

Course Outcomes

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

		Expected Attainment Level In %	Expected Proficiency (grade)
CO1: Explain engineering an the qualities required in a engineering solution and in a engineer	**Understand**	**95**	**S**
CO2. Identify the need and define the problem statement.	**Apply**	**95**	**S**
CO3: Apply engineering design process for the identified problem.	**Apply**	**95**	**S**
CO4: Develop design specification for the identified problem.	**Analyse**	**95**	**S**
CO5: Develop working structure and concepts for the identified problem	**Analyse**		
CO6: Provide embodiment and detail design for the identified problem	**Analyse**		

Mapping with Programme Outcomes

S- Strong; M-Medium; L-Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	S	M	S	-	-	-	S	L	-
CO2	S	M	L	-	-	S	M	S	M	M	-	S	M	L

CO3	S	M	L	-	L	S	M	S	M	M	L	S	L	L
CO4	S	S	M	L	M	M	M	S	S	M	L	S	L	L
CO5	S	S	M	L	M	-	S	S	S	M	L	S	M	M
CO6	S	S	M	L	M	S	S	S	S	S	M	S	M	M

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		
	CAT 1	**Review 1**	**Review 2**
Remember	20	0	0
Understand	40	0	0
Apply	40	100	50
Analyse	0	0	50
Evaluate	0	0	0
Create	0	0	0

- Milestones:
    1. Problem description (3 weeks)
    2. Framework (4 weeks)
        i. Functional requirements
        ii. User requirements
        iii. Performance requirements
        iv. Specifications
    3. Preliminary design (conceptual) (3 weeks)
        i. Cost estimates
    4. Final design (conceptual document) (2 weeks)

Review 1 for milestones1 & 2 and Review 2 for milestones 3 & 4

Course Level Assessment Questions

Course Outcome 1 (CO1):

29. Define Engineering Design
30. State different activities involved in Product Engineering Life Cycle
31. List different design considerations that are required for a good design
32. Explain different types of design
33. List the characteristics of environmentally responsible design

Course Outcome 2 (CO2):

1. List different modes to collect user requirements.
2. Briefly explain the classification of different types of User requirement
3. Define Benchmarking or Reverse Engineering or Product Dissection
4. List two categories of Redesign
5. Explain different activities involved in Design process
6. Explain different steps involved in Conceptual Design process

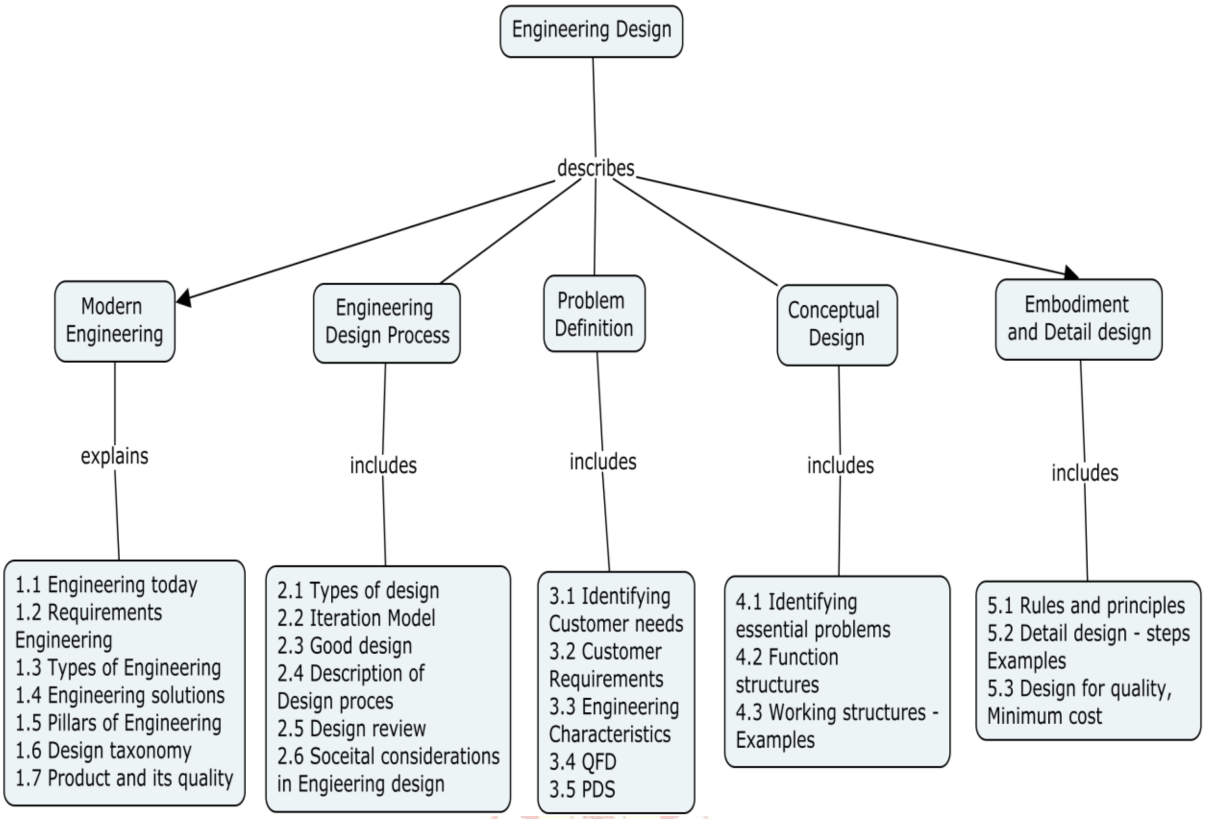
Course Outcome 3 (CO3)

1. Write product design specifications for any of the following product - Desktop Computer or Bicycle or Pencil or Computer Table or mobile.
2. Translate customer requirements into Engineering characteristics of any product like mobile or computer or bicycle.

Course Outcome 4 (CO4)

1. Prepare conceptual design document for any complex engineering problem related to societal engineering under specific domain.

Concept Map



Syllabus

Modern Engineering: Introduction, Engineering today, Requirements of engineering, Types of engineering, Engineering Solutions, Pillars of Engineering, Design Taxonomy, Product, Quality of product.

Engineering Design Process: Types of Designs, A Simplified Iteration Model, Considerations of a Good Design, Description of Design Process, Design Review, Societal Considerations in Engineering Design,

Problem Definition and Need Identification: Identifying Customer Needs, Customer Requirements, Establishing the Engineering Characteristics, Quality Function Deployment, product Design Specification

Conceptual Design: Steps, Abstracting to Identify the Essential Problems, Establishing Function Structures, Developing Working Structures and concepts. Examples

Embodiment and Detail Designs: Steps, Basic Rules and Principles of Embodiment Design, Detail Design, Design for Quality and minimum Cost. Examples

Reference Books

1. **G.Pahl and W.Beitz (Translated by Ken Wallace et al.,) 'Engineering Design: A Systematic Approach, Second Edition, Springer, 2005.**
2. **George E. Dieter and Linda C. Schmidt, "Engineering Design", Fourth Edition, McGraw Hill Higher Education, 2009.**
3. **Power Point Presentation material by Prof.D.K.Subramanian in the Workshop on Engineering Design at TCE, Madurai.**
4. **Foundation Skills in Integrated Product Development, NASSCOM, Edition 2015**

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Modern Engineering**	
1.1	Introduction - Engineering today	1
1.2	Requirements of engineering	
1.3	Types of engineering	1
1.4	Engineering Solutions	
1.5	Pillars of Engineering	
1.6	Design Taxonomy	1
1.7	Product and Quality of product	
2	**Engineering Design Process**	
2.1	Types of Designs	1
2.2	A Simplified Iteration Model	
2.3	Considerations of a Good Design	
2.4	Description of Design Process	1
2.5	Design Review	
2.6	Societal Considerations in Engineering Design	1
3	**Problem Definition and Need Identification**	
3.1	Identifying Customer Needs	1
3.2	Customer Requirements	
3.3	Establishing the Engineering Characteristics	
3.4	Quality Function Deployment	1
3.5	Product Design Specification	
4	**Conceptual Design**	2
4.1	Steps, Abstracting to Identify the Essential Problems	
4.2	Establishing Function Structures	
4.3	Developing Working Structures and concepts - *Examples*	
5	**Embodiment and Detail Design**	2
5.1	Steps, Basic Rules and Principles of Embodiment Design	
5.2	Detail Design – *Examples*	
5.3	Design for Quality and minimum Cost	
	Total Lectures	12

Course Designers:

1. **Dr.S.J.Thiruvengadam** **sjtece@tce.edu**
2. **Dr.S.Baskar** **sbeee@tce.edu**

14CE470	PROFESSIONAL COMMUNICATION	Category	L	T	P	Credit
		PC	1	0	2	2

This course provides opportunities to students to develop and demonstrate basic communication skills in technical, professional and social contexts effectively.

ite

14EG141: English

utcomes

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

			Expected Attainment Level in %	Expected Proficiency Level in grade
CO1:	Plan, organise, write, and present project reports, and technical papers in the frame of the scientific method	Apply		
CO2:	Establish themselves through communication skills in corporate environment	Apply		
CO3:	Solve verbal aptitude questions related to placement and higher studies	Apply		
CO4:	Apply their interpersonal skills in technical, professional and social contexts	Apply		

with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO	-	-	-	-	-	-	-	-	M	M	-	-		
CO	-	-	-	-	-	-	-	-	M	M	-	-		

CO	-	-	-	-	-	-	-	-	M	M	-	-		
CO	-	-	-	-	-	-	-	-	M	M	-	-		

S- Strong; M-Medium; L-Low

ent Pattern

Internal

No Continuous Assessment Test (CAT) will be conducted.

Students' performance will be continuously assessed in various classroom activities in Listening, Speaking, Reading and Writing for 50 marks as detailed below

Project Report Preparation and Technical Presentation through PPT - 15

Listening Test - 10

Spoken Task – Group Discussion / Mock Job Interview - 10

Writing – Verbal Aptitude for Placement and Higher studies - 15

(The test will be conducted for 50 marks and reduced to 15)

External (Practical)

Listening Test - 20

Group Discussion - 25

Personal Interview / Situational Conversation - 25

Technical Presentation - 20

Resume - 10

periments

Sl. No.	Topic	No. of Hours	
		Theory	**Practical**
1	Literature Survey / Project Title Selection	1	
2	Characteristics of Technical Paper and Project Report	1	
3	Abstract / Data Presentation	1	
4	Common Errors in Technical Writing	1	
5	Bibliography and References	1	
6	Vocabulary Development	1	
7	Sentence Completion	1	
8	Error Spotting	1	
9	Interpretation of Verbal Analogy	1	

10	Interpretation of Reading (Comprehension - Conception)	1	
11	Interpretation of Reading (Comprehension - Reasoning)	1	
12	Practice for writing E-mails	1	
13	PPT Preparation /Demonstration of Technical Presentation		4
14	Preparation of Resume		2
15	Preparation for Job Interviews		4
16	Demonstration of Group Discussion Skills		4
17	Developing Listening Skill (Comprehension)		3
18	Practice for Short Speeches / Situational Conversation		4
19	Development of Employability Skills		2
20	Non-Verbal Communication		1
	Total Hours	**12**	**24**

e Books:

1. Courseware on “Technical Communication for Scientists and Engineers”, IIT Bombay, 2015.
2. Cappel, Annette and Sharp, Wendy, Cambridge English: Objective First, 4th Ed., CUP, New Delhi, 2013.
3. Sue Prince, Emma, The Advantage: The 7 Soft Skills You Need to Stay One Step Ahead, Pearson; 1 Edition, 2013.
4. Cusack, Barry. Improve Your IELTS Listening and Speaking Skills (With CD) Paperback, Macmillan, 2007.
5. Bates, Susan TOEFL iBT Exam Paperback – oxford, 2012 .
6. Hart, Guy Brook. Cambridge English Business Benchmark: 2 Ed., CUP 2014

esigners:

1. Dr. T.Sadasivan sadasivan@tce.edu
2. Dr. S.Rajaram sreng@tce.edu
3. Dr. A.Tamilselvi tamilselvi@tce.edu
4. Mr. R.Vinoth vino@tce.edu
5. Dr.R.K.Jaishree Karthiga jai@tce.edu

14CE480	COMPUTER PROGRAMMING LAB	Category	L	T	P	Credit
		PC	0	0	2	1

Preamble

This laboratory course is intended to provide students with opportunities to get hands on training to solve general and Civil Engineering problems using C programming language

Prerequisite

14CE360 -Problem solving using Computer

Course Outcomes

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

			Expected Attainment level in %	Expected Proficiency Level in grade
CO1	Write programme in C for solving mathematical problems	Apply	95	S
CO2	Write programme in C using array of strcutures and string manipulation concept	Apply	95	S
CO3	Write programme in C using pointers to functions	Apply	95	S
CO4	Write programme in C for solving civil survey problems	Apply	95	S
CO5	Write programme in C for solving strength of material problems	Apply	95	S
CO6	Write programme in C for solving fluid mechanics problems	Apply	95	S

with Programme Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO23	S	M	-	L	S	-	-	-	-	L	S	-	M	L
CO24	S	M	-	L	S	-	-	-	-	L	S	-	M	L
CO25	S	M	-	L	S	-	-	-	-	L	S	-	M	L
CO26	S	M	-	L	S	-	-	-	-	L	S	-	M	L
CO27	S	M	-	L	S	-	-	-	-	L	S	-	M	L
CO28	S	M	-	L	S	-	-	-	-	L	S	-	M	L

S- Strong; M-Medium; L-Low

List of Experiments

1. Simple Programs
   a. Fibonacci Series
   b. Sum of set of numbers
   c. Generation of prime numbers
   d. Roots of Quadratic Equation
2. Sum of Series
3. Matrix Addition, Subtraction and Multiplication
4. Arrays of Structures
5. Pointers to functions
6. a)Determination of area and volume of given objects
   b) Determination of area of irregular boundaries
7. Determination of Centre of Gravity and Moment of Inertia of symmetrical

sections

8. Determination of Centre of Gravity and Moment of Inertia of un- symmetrical sections
9. Determination of Shear force and Bending moment of Determinate structures with various load conditions
10. Determination of Slope and Deflection for Determinate structures with various loading conditions
11. Determination of Crippling load for columns with various end conditions
12. Determination of head loss due to friction in pipes
13. Determination of unknown area of cross section of a varying pipe line using the Bernoulli's Theorem and continuity equation
14. Determination of shortest route between cities

Reference Books

1. Byron S.Gottfried, Schaum's Outline series, "Programming w ith C", McGraw Hill Education (India) Pvt Ltd, Third Edition, 2010
2. Yashavant Kanetkar, "Let us C", Bpb Publishers, 13th Edition, 2012.
3. Al Kelley and Ira Pohl, "A Book On C", Addison-Wesley , Fourth Edition, 1998

Course Designers

1. Dr. G. Chitra gcciv@tce.edu
2. Dr. D. Brindha dbciv@tce.edu

14CE490 **FLUID MECHANICS AND MACHINERY LAB**

Category	L	T	P	Credit
PC	0	0	2	1

Preamble

This laboratory is used in conjunction with fluid mechanics course in reinforcing the fundamentals of fluid mechanics and machinery by hands on experiment.

Prerequisite

Engineering Mathematics, Physics and Fluid Mechanics.

Course Outcomes

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

			Expected Attainment level in %	Expected Proficiency level in grade
CO1	Measure the flow in pipe section using orificemeter and venturimeter	Apply	95	S
CO2	Measure the flow in the open channels using notches	Apply	95	S
CO3	Measure and compute the major and minor losses in pipes	Apply	95	S
CO4	Verify the Bernoulli's theorem	Apply	95	S
CO5	Study the performance of different types of hydraulic turbines	Apply	95	S
CO6	Study the performance of different types of pumps	Apply	95	S

vith Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO29	M	L	-	-	-	-	-	-	-	L	-	-	L	L
CO30	M	L	-	-	-	-	-	-	-	L	-	-	L	L
CO31	S	S	M	M	-	-	-	-	-	L	-	-	L	L
CO32	S	S	-	-	-	-	-	-	-	L	-	-	L	L
CO33	S	M	M	M	-	-	-	-	-	L	-	-	M	L
CO34	S	M	M	M	-	-	-	-	-	L	-	-	M	L

S- Strong; M-Medium; L-Low

List of Experiments

1. Determination of coefficient of discharge of orifice.
2. Flow measurement in pipe using orificemeter
3. Flow measurement in pipe using venturimeter
4. Flow measurement in open channel using notches
5. Determination of frictional loss in pipes
6. Determination of minor losses in pipes
7. Verification of Bernoulli's theorem
8. Determination of laminar-turbulent flow in pipes using Reynold's apparatus
9. Determination of metecentric height of a floating body
10. Performance test on Pelton wheel turbine
11. Performance test on Francis turbine
12. Study of impact of jet on vanes
13. Performance test on multi-stage centrifugal pump
14. Performance test on reciprocating pump
15. Performance test on submersible pump.

Reference Books

1. Modi P.N and Seth S.M, “Hydraulics and Fluid Mechanics Including Hydraulic Machines” Standard Book House” New Delhi, 20th Edition 2015.
2. Bansal R.K, “ Fluid Mechanics and Hydraulic Machines” Laxmi Publications, New Delhi, 2015.
3. Rajput. R.K, “ A Text book of Fluid Mechanics and Hydraulic Machines”, S.Chand and Company, New Delhi,2011.

Course Designers

3. Dr.S.Chandran schandran@tce.edu
4. M.Ramasamy mrciv@tce.edu
5. Dr.T.Baskaran tbciv@tce.edu

14CE440	WASTEWATER ENGINEERING	Category	L	T	P	Credit
		PC	2	2	0	3

Preamble

This course work aims at imparting the basic knowledge on various stages of works involved in planning, designing and execution of underground drainage system for a town/ city. This involves characteristics study on wastewater, estimation of wastewater and storm drainage generation, collection of wastewater, evolving a suitable treatment system to bring down the pollution level to acceptable limit and disposal of the treated wastewater on to land/ water bodies without endangering the environment.

Prerequisite

Fundamentals of Chemistry, Fluid mechanics and Water supply Engineering.

Course Outcomes

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

		Expected Attainment level in %	Expected Proficiency Level in grade
CO1. Characterize the wastewater generated from a town/ city	Apply	70	A
CO2. Estimate the quantity of wastewater and storm run-off generated from the town/ city	Apply	70	A
CO3. Design a suitable collection system for the generated wastewater	Apply	70	A
CO4. Identify the sewer appurtenances needed for the smooth functioning of the sewerage and to perform the necessary maintenance operations involved in the system	Understand	70	A
CO5. Design the necessary treatment units for the wastewater collected from the town/city	Apply	70	A
CO6. Identify the suitable mode of disposal for the treated wastewater without endangering the environment.	Apply	70	A

Mapping with Programme Outcomes

S- Strong; M-Medium; L-Low

COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O 2
CO21.	S	S	M	M	-	M	S	-	-	-	-	-	M	L
CO22.	S	S	M	S	-	M	-	-	M	M	-	-	M	L
CO3.	S	S	S	S	-	S	S	M	-	-	-	-	M	L
CO4.	M	M	S	S	-	S	M	-	S	S	-	-	M	M
CO5.	S	S	S	S	-	S	S	-	-	M	-	-	M	L
CO6.	S	S	S	S	-	S	S	S	S	S	-	-	M	M

Assessment Pattern

Bloom's Category	Continuous Assessment Tests	Terminal Examination

	1	2	3	
Remember	**20**	**20**	**20**	**20**
Understand	**40**	**30**	**30**	**30**
Apply	**40**	**50**	**50**	**50**
Analyse	**--**	**--**	**--**	**--**
Evaluate	**--**	**--**	**--**	**--**
Create	**--**	**--**	**--**	**--**

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is Population equivalent
2. The 7 days 20˚C BOD of a sample of sewage is 300mg/L and its 3days 20˚C BOD is 210mg/L. find out the value of de-oxygenation constant k and then estimate its 5 days 30˚C BOD.
3. The sewage discharge of a city is 85m3/s in the river having a minimum discharge of 930 l/s with a velocity of 0.12m/s. the BOD at 20˚C of the sewage is 325mg/L. the BOD of the river is zero. Determine the quantity and point of critical DO deficit.

Course Outcome 2 (CO2)

4. A district consists of 20% of area with runoff coefficient 0.9,20% of area with runoff coefficient 0.85,5% of area with 0.80,15% of area with 0.40 runoff coefficient, 35% of area with runoff coefficient 0.10 and remaining area with runoff efficient 0.05; determine the co-efficient of runoff for the area. If the total area of the district is 36 hectares and the maximum rain intensity is taken as 5cm/hr; what is the total runoff for the district? If the density of population is 250 per hectare and the rate of water supply is 200lit/day/capita. Calculate the quantity of sewage for which the sewer of a separate system is to be designed.
5. A 30cm dia sewer having an invert slope of 1 in 150 was flowing full. What would be the velocity of flow and discharge. N=0.013. Is the velocity self cleansing? What would be the velocity and discharge when the same is flowing at 0.20 and 0.80 of the full depth.
6. Suggest a suitable sewage collection system for a town with a population of 5.0 Lakhs. This town is very old with narrow lay- out of roads and streets.
7. With a help of a neat sketch, propose a wastewater collection system for a house with 2 bed rooms, 1 Hall, 1 sit-out, 1 kitchen etc.

Course Outcome 3 (CO3):

1. Discuss the role of velocity of flow in hydraulic design of sewers
2. Justify the usage of various sewer appurtenances for the efficient performance of sewerage.
3. Justify the usage of circular shaped sewers than other sections.
4. Design a grit chamber system for a town with a population of 1.0 Lakh. Assume necessary design parameters appropriately.

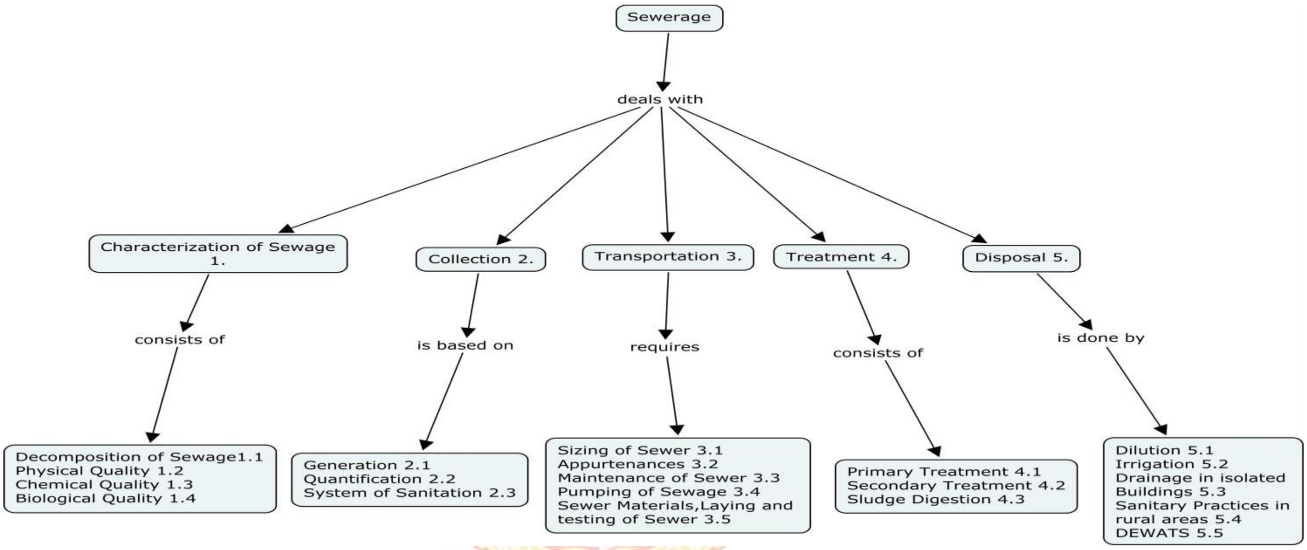
Course Outcome 4 (CO4):

4. Design a standard rate trickling filter for the following:
   Average incoming flow=350m3/hr
   BOD of primary effluent=210mg/L
   No of units=4
   Make suitable assumptions for any missing data.
5. A sedimentation tank treating 4.5 million liters of sewage per day containing 275mg/L of suspended solids. The tank removes 50% suspended solids. Calculate the quantity of sludge produced per day in volume basis & weight basis, if (i) moisture content is 98% (ii) moisture content is 96%
6. Why do we go for anaerobic treatment of sewage? Analyze the performance of different anaerobic treatment system?
7. A city with a population of 2.0 Lakhs is to be provided with a secondary treatment facility. Suggest a treatment system and make a complete design.

Course Outcome 5 (CO5):

4. Design a septic tank for the following data:
   No of people=100
   Sewage/capita/day=120L
   Desludging period=1yr
   L:B=4:1
5. Design a septic tank unit for a housing colony with 100 persons. Also design the suitable effluent percolation unit.
6. Suggest a disposal system for a town where the water scarcity is very high.

Concept Map



Syllabus

Characteristics of sewage, decomposition – aerobic and anaerobic decomposition- physical and chemical quality of sewage – BOD and their testing– BOD equation – problems – population equivalent. Systems of sanitation– Estimating quantity of sewage – dry weather flow – estimating storm run-off by rational formula – Sewerage – separate, combined and partially separate system – hydraulic design of sewers. Sewer materials - laying and testing of sewer sewer appurtenances, cleaning and ventilation of sewers- pumping of sewage. Physico - chemical treatment of sewage. Biological treatment of sewage – aerobic treatment - activated sludge process – process mechanism, design parameters, design – modifications in ASP. Trickling filters – process mechanism, types, design parameters and design. Hybrid system – SBR, MBR , MBBR (basics only). Natural systems - Ponds and Lagoons. Anaerobic systems – UASB, anaerobic filters and natural systems. Sludge digestion – characteristics- digestion tanks, design - disposal of digested sludge. Impact of disposal of treated sewage – Impact on river – self purification – oxygen sag curve – streeter phelps equation – Impact on lakes – Eutrophication – Impact on sea. Land irrigation – sewage farming, sewage sickness. Recycling of treated sewage. Disposal of sewage in isolated buildings, plumbing system – types; Sanitary practices in rural areas. ECOSAN, Introduction to DEWATS.

Text Book

1. Garg S.K.: "Sewage Disposal and Air Pollution Engineering", Khanna Publishers New Delhi 2015.
2. Metcalf & Eddy :"Wastewater Engineering Treatment and Reuse" , Tata McGraw Hill Publishers, New Delhi, 2010.

Reference Books

1. Peavy, Rowe, Tchobanoglous, “Environmental Engineering”, McGraw Hill Publishers, New Delhi, 2013.
2. Punmia B.C, Ashok Jain, “Wastewater Engineering”, Laxmi publications, New Delhi, 1998.
3. Mark J.Hammer, Mark J.Hammer,Jr, “Water and Wastewater Technology”,Prentice Hall of India Pvt.Ltd.,New Delhi,2011.
4. Manual on sewerage and sewage treatment, CPHEEO, Ministry of urban affairs & employment, Govt.of India, New Delhi,2013.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	Characterization of sewage	
1.1	**Aerobic and anaerobic decomposition of sewage**	**1**
1.2	**Physical quality of sewage**	
1.3	**Chemical quality of sewage**	
1.3.1	**BOD , testing procedure and BOD equation**	**1**
1.3.2	**Problems in BOD and population equivalent – Tutorial**	**2**
1.4	**Biological quality of sewage**	**1**
2.0	Collection of sewage	
2.1	**Generation of sewage**	**1**
2.2	**Quantification of sewage- estimation**	
2.2.1	**Estimation of storm runoff**	**1**
2.3	**System of sanitation**	**1**
	Estimation of storm runoff – Tutorial	**2**
3.0	Transportation of wastewater	
3.1	**Hydraulic design of sewer- principle**	**1**
3.1.1	**Problems in Hydraulic design of sewer –Tutorial**	**4**
3.2	**Sewer appurtenances**	**1**
3.3	**Maintenance of sewer**	**1**
3.4	**Pumping of sewage**	
3.5	**Sewer material, laying and testing of sewer**	
4.0	Treatment of wastewater	
4.1	**Objectives of treatment – Physico - chemical treatment**	**1**
4.2	**Aerobic treatment – activated sludge process- process mechanism**	**1**
4.2.1	**Methods of aeration**	**1**
4.2.2	**Design consideration and design - Tutorial**	**4**
4.2.3	**Modification in ASP**	**1**
4.2.4	**Trickling filters- process mechanism, types**	
4.2.5	**Design consideration – standard rate trickling filter**	**1**
4.2.6	**Design of standard rate trickling filter - Tutorial**	**2**
4.2.7	**High rate trickling filter- design – Tutorial**	**2**
4.2.8	**Hybrid system- SBR, MBR, MBBR**	**1**
4.2.9	**Natural systems – ponds and lagoons**	**1**
4.3	**Anaerobic system- UASB**	
4.3.1	**Anaerobic filter, natural system**	**1**
4.4	**Sludge digestion- characteristics of sludge, digestion tanks**	**1**
4.4.1	**Design of digestion tank and disposal of digested sludge**	
	Sludge digestion tanks and Sludge Characteristics - Tutorial	**2**
5.0	Impact of disposal of sewage	
5.1	**Impact of disposal of treated sewage – Impact on river**	**1**
5.1.1	**Self purification of streams**	
5.1.2	**Oxygen sag curve for streams**	**1**
5.1.3	**Streeter phelps equation- problems – Tutorial**	**4**

Module No.	Topic	No. of Lectures
5.1.4	**Impact on lakes- eutrophication**	**1**
5.1.5	**Impact on sea**	
5.2	**Land irrigation- sewage farming**	**1**
5.2.1	**Sewage sickness**	
5.3	**Drainage system in isolated buildings- septic tanks – Tutorial**	**2**
5.3.1	**Plumbing system- types**	**1**
5.3.2	**Sanitary practices in rural areas, ECOSAN**	**1**
5.4	**Introduction to DEWATS**	
	Total hours (24 +24)	48

Course Designers:

1. Dr. T. Vel Rajan tvciv@tce.edu
2. Mr. V. Ravi sankar environmentengr@tce.edu

14CE510	MATHEMATICS V	Category	L	T	P	Credit
		BS	2	2	0	3

Preamble

Numerical methods in civil engineering can be used to solve mathematical models of civil engineering problems. Mathematical models are many and cover every discipline encompassed by civil engineering. Given the mathematical description of a problem a numerical method lays down, the broad approach to be adopted to solve the problem numerically.

Prerequisite

- 14MA110 Engineering Mathematics
- 14CE310 Fourier Series and Partial Differential Equations

Course Outcomes

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

At the end of the course the student will be able to:			Expected Attainment level in %	Expected Proficiency Level in grade
CO1:	Organize the system of linear algebraic equations and single non linear equations arising in the field of Civil Engineering	Apply	75	A
CO2:	Interpolate discrete data by means of continuous function.	Apply	75	A
CO3:	Evaluate the integration of one and two variable functions using numerical tools and calculate derivatives using interpolation polynomial.	Apply	75	A
CO4:	Identify the solution for the IVPs in ODE using single step and multistep methods and BVPs in PDE using finite difference methods.	Apply	75	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	L									S	S
CO2	S	L	L	L		L							S	L
CO3.	S	L	L	S									L	L
CO4.	S	L	L	S									S	

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	20	20	20	20
Apply	70	70	70	70
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. A civil engineer involved in construction requires 4800, 5800, and 5700 m3 of sand, fine gravel, and coarse gravel, respectively, for a building project. There are three pits from which these materials can be obtained. The composition of these pits is

	Sand %	Fine Gravel %	Coarse Gravel %
Pit 1	52	30	18
Pit 2	20	50	30
Pit 3	25	20	55

How many cubic meters must be hauled from each pit in order to meet the engineer's needs?

2. The upward velocity of a rocket is given at three different times in the following table

Velocity vs. time data.

Time, t(s)	Velocity, v (m/s)
5	106.8
8	177.2
12	279.2

The velocity data is approximated by a polynomial as $v(t) = a_1 t^2 + a_2 t + a_3 \quad 5 \le t \le 12$ .Find

the values of a_1,a_2 and a_3 using the Gauss-Seidel method. Assume an initial guess of the solution as $\begin{bmatrix} a_1 \\ a_2 \\ a_3 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 5 \end{bmatrix}$ and conduct two iterations.

3. A loan of A dollars is repaid by making n equal monthly payments of M dollars, starting a month after the loan is made. It can be shown that if the monthly interest rate is r, then Ar = $M(1-\frac{1}{(1+r)^n})$. A car loan of $10000 was repaid in 60 monthly payments of $250. Use the Newton Method to find the monthly interest rate correct to 4 significant figures.

Course Outcome 2 (CO2):

1. Write the recurrence formula used in cubic spline interpolation.
2. Use Newton's interpolating polynomial to determine *y* at *x* =3.5 to the best possible accuracy. Compute the finite divided differences and order your points to attain optimal accuracy and convergence.

x	0	1	2.5	3	4.5	5	6
y	2	5.4375	7.3516	7.5625	8.4453	9.1875	12

3. The following data defines the sea-level concentration of dissolved oxygen for fresh water as a function of temperature:

T$^{\circ}$C	0	8	16	24	32	40
O,mg/L	14.621	11.843	9.870	8.418	7.305	6.413

Estimate *o*(27) using **(a)** linear interpolation, **(b)** Newton's interpolating polynomial, and **(c)** cubic splines. Note that the exact result is 7.986 mg/L.

34. Course Outcome 3 (CO3):

1. Mention the formula for computing the first two derivatives using Newton's forward difference formula.
2. Stream cross-sectional areas (*A*) are required for a number of tasks in water resources engineering, including flood forecasting and reservoir designing. Unless electronic sounding devices are available to obtain continuous profiles of the channel bottom, the engineer must rely on discrete depth measurements to compute *A*.An example of a typical stream cross section is shown in Fig. The data points represent locations where a boat was anchored and depth readings taken. Use two trapezoidal rule applications (*h* = 4 and 2 m) and Simpson's 1/3 rule (*h* = 2 m) to estimate the cross sectional area from this data.

3. Wind force distributed against the side of a skyscraper is measured as:

Height, *l*, m	0	30	60	90	120	150	180	210	240
Force, *F*(*l*), N/m	0	340	1200	1600	2700	3100	3200	3500	3800

Compute the net force and the line of action due to this distributed wind.

35.

36. Course Outcome 4 (CO4):

1. Differentiate between single step and multistep method in solving ordinary differential equations.

2. The following equation can be used to model the deflection of a sailboat mast subject to a wind force: $\frac{d^2y}{dz^2} = \frac{f}{2EI}(L-z)^2$ where *f* = wind force, *E* = modulus of elasticity, *L* = mast length, and *I* = moment of inertia. Calculate the deflection if *y* = 0 and *dy/dz* = 0 at *z* = 0. Use parameter values of *f* = 60, *L* = 30, *E* = 1.25 × 108,and *I* = 0.05 for your computation.

3. Solve the following initial value problem over the interval from *t* = 0 to 2 where *y*(0) = 1.

$\frac{dy}{dt} yt^3 - 1.5y$ *dy=0.*

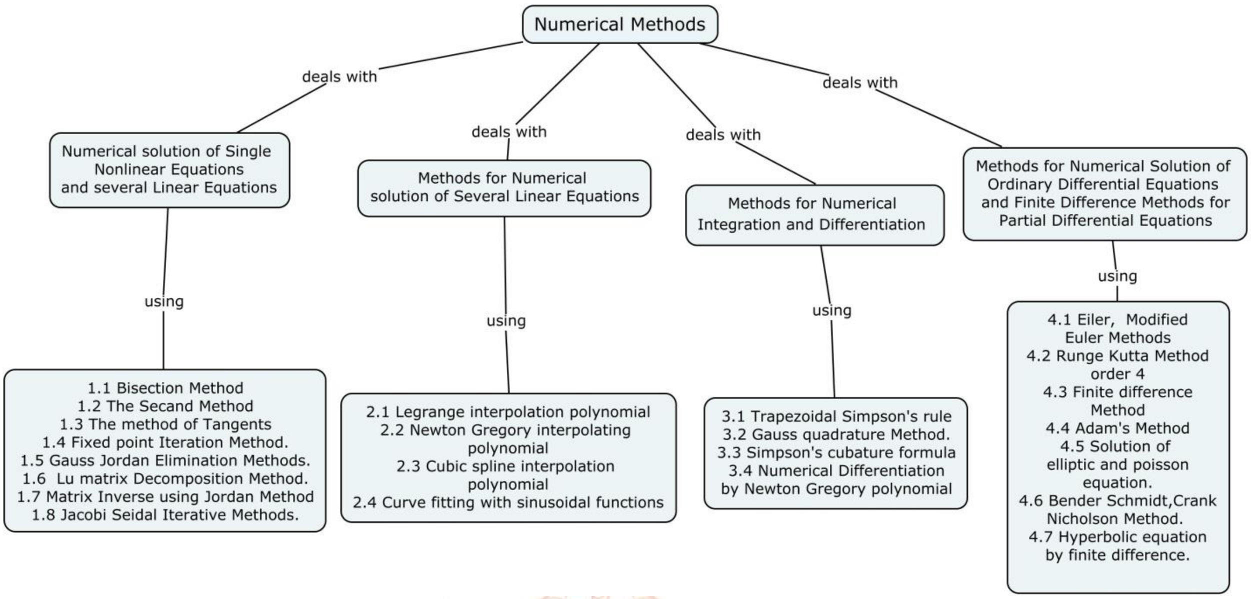
(a) Analytically.

(b) Euler's method with *h* = 0.5 and 0.25.

(c) Midpoint method with *h* = 0.5.

(d) Fourth-order RK method with *h* = 0.5.

Concept Map



Syllabus

Methods for Numerical solution of Single Nonlinear Equations: Bisection Method - The Secant Method - The method of Tangents (Newton-Raphson), convergence - Fixed Point Iteration method, convergence. **Methods for Numerical solution of Several Linear Equations:** Gauss, Jordan elimination methods - LU Matrix Decomposition Method, Method of Inverse of a Matrix using Jordan method - Jacobi, Seidal Iterative Methods, convergence **Methods for the Interpolation and Approximation of Single Variable Function:** Lagrange Interpolation Polynomial - Newton Gregory Interpolating Polynomial - Cubic Spline Interpolation Polynomial - Curve Fitting with sinusoidal functions. **Methods for Numerical Integration and Differentiation:** Newton Cote's methods of Integration, Trapezoidal, Simpson rule - Gauss Quadrature method - Simpson's cubature formula for Integration of Two variable Functions - Numerical differentiation by using Newton-Gregory polynomial. **Methods for Numerical Solution of Ordinary Differential Equations and Finite Difference Methods for Partial Differential Equations:** The Euler, Modified Euler methods - Runge Kutta Method RK4, Finite difference method - Adam - Bashforth method - Solution of Elliptic equation for Laplace and Poisson equation - Parabolic equation by Bender Schmidt Method, Crank-Nicolson Scheme - Hyperbolic equation by finite difference.

Text Books

1. Steven C. Chapra, Raymond P. Canale, "Numerical Methods for Engineers", MC Graw Hill Higher Education, 6th Edition 2012.
2. S. R. K. Iyengar, R. K. Jain, Mahinder Kumar Jain, "Numerical methods for Scientific and Engineering Computations", New Age International publishers , 6th Edition, 2012.

Reference Books

1. S.K Gupta, "Numerical Methods for Engineers", New Age International Pvt Ltd Publishers, 2015.
2. Joe D. Hoffman , Steven Frankel, "Numerical Methods for Engineers and Scientists", Third Edition, 2015.

Course Contents and Lecture Schedule

Module No	Topic	No.of Lectures
1	**Methods for Numerical solution of Single Nonlinear Equations and Several Linear Equations**	
1.1	Introduction to Numerical Methods, Bisection Method	1
	Tutorial	1
1.2	The Secant Method	1
	Tutorial	1
1.3	The method of Tangents (Newton-Raphson), convergence	1
	Tutorial	1
1.4	Fixed Point Iteration method, convergence	1
	Tutorial	1
1.5	Gauss, Jordan elimination methods	1
	Tutorial	1
1.6	LU Matrix Decomposition Method	1
	Tutorial	1
1.7	Method of Inverse of a Matrix using Jordan method	1
	Tutorial	1
1.8	Jacobi , Seidal Iterative Methods, , convergence	1
	Tutorial	1
2	**Methods for the Interpolation and Approximation of Single Variable Function**	
2.1	Lagrange Interpolation Polynomial	1
	Tutorial	1
2.2	Newton Gregory Interpolating Polynomial	1
	Tutorial	1
2.3	Cubic Spline Interpolation Polynomial	1
	Tutorial	1
2.4	Curve Fitting with sinusoidal functions.	1
	Tutorial	1
3	**Methods for Numerical Integration and Differentiation**	
3.1	Newton Cote's methods of Integration,Trapezoidal, Simpson rule	1
	Tutorial	1
3.2	Gauss Quadrature method	1
	Tutorial	1
3.3	Simpson's cubature formula for Integration of Two variable Functions	1
	Tutorial	1
3.4	Numerical differentiation by using Newton-Gregory polynomial.	1
	Tutorial	1
4	**Methods for Numerical Solution of Ordinary Differential Equations and Finite Difference Methods for Partial Differential Equations**	

Module No	Topic	No.of Lectures
4.1	The Euler, Modified Euler methods	1
	Tutorial	1
4.2	Runge Kutta Method order 4	1
	Tutorial	1
4.3	Finite Difference	1
	Tutorial	1
4.4	Milne's Method.	1
	Tutorial	1
4.5	Adam - Bashforth Method	1
	Tutorial	1
4.6	Solution Elliptic equation for Laplace and Poisson equation	2
	Tutorial	1
4.7	Parabolic equation by Bender Schmidt Method, Crank-Nicolson Scheme	1
	Tutorial	1
4.8	Hyperbolic equation by finite difference	1
	Total	**48**

* Tutorials problems are to be solved using MatLab/Maple Software.

Course Designers:

1.Prof. P.subramanian psmat@tce.edu
2. Dr.M.Sivanandha Saraswathy sivanandha@tce.edu
3. Dr.N.Chitra ncmat@tce.edu

14CE520	ENGINEERING HYDROLOGY	Category	L	T	P	Credit
		PC	2	0	0	2

Preamble

It is the science that deals with the waters of the earth, their occurrence, circulation, distribution and their reaction with environment including their relation to living things.

Course Outcomes

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

		Expected Attainment level in %	Expected Proficiency Level in grade
(CO1) Explain the importance of Hydrological cycle and the measurement and analysis of rainfall data.	**Understand**	**75**	**A**
(CO2) Estimate the losses viz evaporation, evapotranspiration and infiltration for a catchment area	**Apply**	**75**	**A**
(CO3) Compute the quantity of runoff generated from a catchment	**Apply**	**75**	**A**
(CO4) Develop hydrographs to measure the stream flow	**Apply**	**75**	**A**
(CO5) Estimate floods and propose suitable control measures	**Apply**	**75**	**A**
(CO6) Suggest methods of conserving surface and groundwater storage	**Apply**	**75**	**A**

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO23.	L	M	-	-	-	L	S	L	-	-	-	---	L	L
CO24.	M	M	-	L	-	--	S	-	---	-	---	---	L	L
CO3.	S	M	L	L	-	-	S	-	---	-	---	---	L	L
CO4.	S	M	L	L	-	-	M	-	---	-	-	-	L	L
CO5.	S	M	-	L	-	-	S	-	-	---	---	-	L	L
CO6.	L	-	L	-	-	L	M	L	L	L	-	-	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	

Remember	20	20	20	20
Understand	40	30	30	30
Apply	40	50	50	50
Analyse	---	---	---	---
Evaluate	---	---	---	---
Create	---	---	---	---

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Describe the principle of working of a tipping bucket type recording rain gauge with a neat sketch. What are its advantages and disadvantages?
2. How is the double mass curve techniques used to check the consistency and adjust the rainfall record at a suspicious station?
3. A catchment has six rain gauge station. In a year, the annual rainfall recorded by the gauges are given below. For a 10% error in the estimation of the mean rainfall, calculate the optimum number of stations in the catchment.

Station	A	B	C	D	E	F
Rainfall (cm)	120.2	118.6	119.3	125.2	100.2	119.9

4. For a drainage basin of 700 km^2, isohyetals drawn for a storm gave the following data. Estimate the average depth of precipitation over the catchment.

Isohyetals (Interval) (cm)	15-12	12-9	9-6	6-3	3-1
Inter-isohyetal area (km^2)	92	128	120	175	85

Course Outcome 2 (CO2):

1. Describe how infiltration capacity rate can be measured using double ring infiltrometer. How is it better than a tube infiltrometer?
2. A 6h storm produced rainfall intensities of 7, 18, 25, 12, 10, and 3mm/h in successive one hour intervals over a basin of 800 sq.km. The resulting runoff is observed to be 2640 hectare-metres. Determine Φ-index for the basin.
3. Write down the most common empirical formula used to calculate evaporation from a water body also explain the factors influencing evaporation.
4. Estimate the daily evaporation from a small reservoir using Horton and Mayer equations from the following data:
   Water surface temperature=24^0C, Air temperature=26^0C, Atmospheric pressure=752 mm of mercury, Relative humidity=46%, Wind speed at 0.5m above ground=25.3 km/h, Saturation vapour pressure (water)=22.43mm of mercury, Saturation vapour pressure (air)=25.27mm of mercury.

Course Outcome 3 (CO3):

1. Distinguish between runoff and base flow with the factors affecting runoff.
2. Draw the typical hydrograph and mention its components. Explain the methods of base flow separation.
3. The ordinates of 4 hour unit hydrograph are given below. Determine the ordinates of 12 hr unit hydrograph.

Time (hr)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28
Ordinates in m^3/s	0	13	21	24	18	15	12	10	8.3	6.5	5	4	3	1	0

4. Describe the step by step procedure of the derivation of a unit hydrograph from an isolated storm.

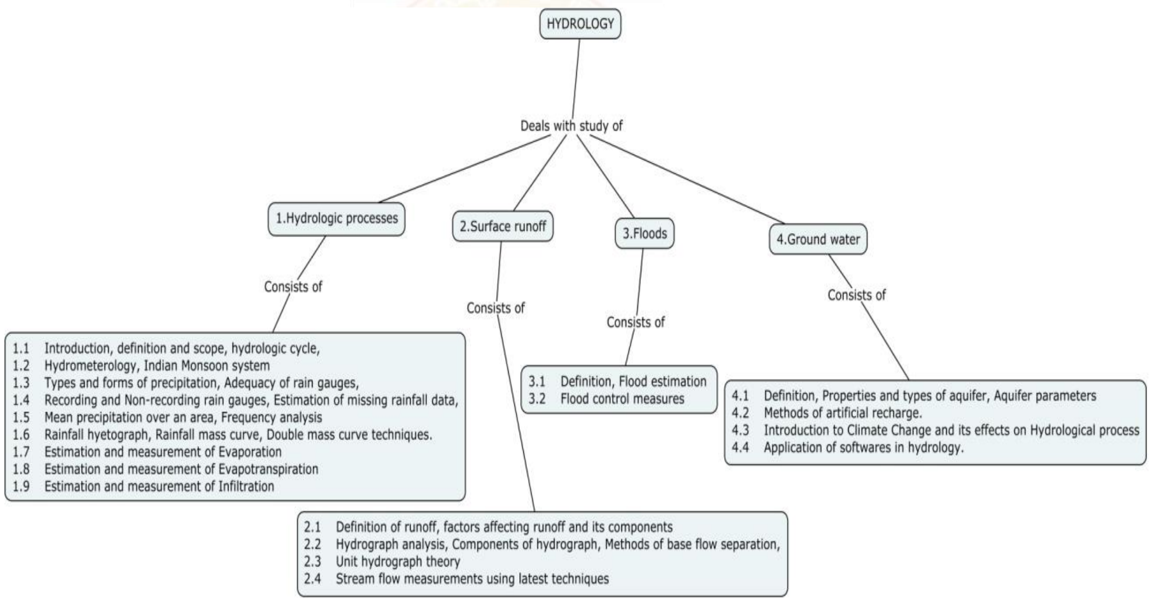
Course Outcome 4 (CO4):

1. What is a design flood?
2. Define MPF.
3. What are the different types flood control methods? Explain
4. Explain the different methods of estimating design floods with their limitation?

Course Outcome 5 (CO5):

1. Distinguish natural and artificial recharge of groundwater. Enumerate different methods adopted for recharging the groundwater.
2. Enumerate the methods which are used for determining the yield of a well. Discuss briefly.
3. List the different types of aquifers and also explain their properties.
4. Distinguish between surface runoff and subsurface runoff

Concept Map



Syllabus

Hydrologic processes: Introduction, definition and scope, hydrologic cycle, Hydrometeorology, Indian Monsoon system, Types and forms of precipitation, Adequacy of rain gauges, Recording and Non-recording rain gauges, Estimation of missing rainfall data, Mean precipitation over an area, Frequency analysis, Rainfall hyetograph, Rainfall mass curve, Double mass curve techniques. Estimation and measurement of Evaporation, Evapotranspiration and Infiltration. **Surface runoff:** Definition of runoff, factors affecting runoff and its components, Hydrograph analysis, Components of hydrograph, Methods of base flow separation, Unit hydrograph and Stream flow measurements using latest techniques. **Floods**: Definition, Flood estimation and its control. **Ground water:** Definition, Properties and types of aquifer, Aquifer parameters, Methods of artificial recharge. Introduction to Climate Change and its effects on Hydrological process. Application of software in hydrology.

Text Book

1. Subramanya.K.,Engineering Hydrology, Tata McGraw Hill, New Delhi, 2013
2. JayaramiReddy.P. Hydrology, Tata McGraw Hill, New Delhi, 2011.
3. Ragunath.H.,Hydrology, Wiley Eastern Limited, New Delhi, 2010.

Reference Books

1. VenTe. Chow, Maidment D.R. and Mays L.W. Applied Hydrology, McGraw Hill International Book Company New York, 1995.
2. VenTe Chow, Hand book of Applied Hydrology, McGraw Hill Book Co., Inc., New York, 1964.
3. www.nptel.ac.in
4. http://www.unece.org/fileadmin/DAM/env/water/publications/documents/Guidance_water_climate.pdf
5. http://www.cwc.nic.in/main/downloads/Combined%20Final_HDD_09042012.pdf
6. http://www.unep.org/pdf/IEA_climate_change.pdf

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Hydrologic processes**	
1.1	Introduction, definition and scope, hydrologic cycle,	1
1.2	Hydrometeorology, Indian Monsoon system	1
1.3	Types and forms of precipitation, Adequacy of rain gauges,	1
1.4	Recording and Non-recording rain gauges, Estimation of missing rainfall data,	2
1.5	Mean precipitation over an area, Frequency analysis	2
1.6	Rainfall hyetograph, Rainfall mass curve, Double mass curve techniques.	1
1.7	Estimation and measurement of Evaporation	1
1.8	Estimation and measurement of Evapotranspiration	1

Category	L	T	P	Credit
PC	2	2	0	3

1.9	Estimation and measurement of Infiltration	1
2	**Surface runoff**	
2.1	Definition of runoff, factors affecting runoff and its components	1
2.2	Hydrograph analysis, Components of hydrograph, Methods of base flow separation,	1
2.3	Unit hydrograph theory	2
2.4	Stream flow measurements using latest techniques	1
3	**Floods**	
3.1	Definition, Flood estimation	2
3.2	Flood control measures	1
4	**Ground water**	
4.1	Definition, Properties and types of aquifer, Aquifer parameters	1
4.2	Methods of artificial recharge.	2
4.3	Introduction to Climate Change and its effects on Hydrological process	1
4.4	Application of software in hydrology.	1
	Total Hours	**24**

Course Designers:

1. Dr.S.Chandran scciv@tce.edu
2. Mr.M.Ramasamy mrciv@tce.edu
3. Dr.T.Baskaran tbciv@tce.edu

14CE530 **SOIL MECHANICS**

Preamble

This course is a branch of Civil Engineering which deals with the application of laws of Mechanics and Hydraulics to Engineering problems related with soils like Permeability, stresses within soils, Shear strength and compressibility of soils. These form the basis for the computation of discharge through earthen dams, shear strength parameters required for determining the bearing capacity of soils and calculating settlement of structures.

Prerequisite

Fundamentals of Mathematics, knowledge of geology and earth science.

Course Outcomes

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

			Expected Attainment Level in %	Expected Proficiency Level in grade
CO1	Compute the basic properties of soils and classify the Soil according to AASHTO, USCS and IS Soil classification system	Understand	70	A
CO2	Determine the Permeability of Cohesive and Cohesionless soils	Apply	70	A
CO3	Calculate Effective stress within soils and	Apply	70	A
CO4	Compute the Shear Strength of soils based on the parameters obtained from shear	Apply	70	A
CO5	Estimate consolidation parameters and compute consolidation	Apply	70	A
CO6	settlement of foundation	Apply	70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO 1	PSO 2
CO25.	L	-	-	L	-	-	-	-	-	L	M	-	L	-
CO26.	M	L	-	L	L	L	-	-	-	L	M	-	M	-
CO3.	S	S	-	M	M	L	-	-	-	L	M	-	S	-
CO4.	M	M	-	S	-	L	-	-	-	L	M	-	M	-
CO5.	S	S	-	S	M	L	-	-	-	L	M	-	S	-
CO6.	S	L	-	S	M	M	-	-	-	L	M	-	S	-

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	20	10	10	10
Apply	70	80	80	80
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Course Level Assessment Questions

CO1 Explain the basic properties of soils and classify the Soil

1. Distinguish between Index and Engineering properties.
2. The following data relate to 5 fine grained soil samples.

L.L (%)	25	45	50	60	80
P.L (%)	15	23	25	35	36

   Plot these on a Casagrande's A-line chart and classify the soils.

3. An imaginary soil mass is contained in a container measuring 10cm x 10cm x 10cm. The soil consists of spherical grains of size 1cm in diameter. Determine the maximum possible void ratio and percentage solids.

CO2 Determine the Permeability of Cohesive and Cohesionless soils

1. A constant head permeability test was carried out on a cylindrical sample of sand 10cm diameter and 15cm height. 200 cc of water is collected in 2 mins under a head of 30cm. Compute the coefficient of permeability in m/year. Also calculate the discharge velocity and seepage velocity if void ratio of the sample is 0.75.
2. A falling head permeability test is to be performed on a soil ample whose permeability is estimated to be 3 x 10^{-5}cm/s. What diameter of the stand pipe should be used if the head is to drop from 27.5cm to 20.0 cm in 5 minutes and if the cross sectional area and length of the sample are respectively 15cm^2 and 8.5cm? Will it take same time for the head to drop from 37.7cm to 30.0cm?
3. List out the factors affecting permeability of soil.

CO3 Calculate Effective stress within soils and stress due to external loads

1. Water table is lowered from a depth of 3m to a depth of 6m in a deposit of silt. The silt deposit has a water content of 20%. Its degree of saturation above water table is 65%.Estimate the increase in effective stress at a depth of 10m due to lowering of the water table. Assume G=2.7.
2. Explain Quick sand condition in soil.
3. Explain the step by step procedure of constructing the Newmark's influence chart.
4. A square footing 2m x 2m resting on the surface of a soil exerts a pressure of 150kN/m^2. Determine the stress at a point which is at a depth of 5m below the center of the footing using Boussinesq's theory.

CO4 Compute the Shear Strength of soils based on the parameters obtained from shear tests

1. Consolidated Undrained triaxial tests are performed on two identical specimens of saturated, remoulded clay with pore pressure measurements. The observations are recorded in the table below

Test No.	Cell pressure at failure (kN/m^2)	Deviator stress at failure (kN/m^2)	Pore pressure at failure (kN/m^2)
1.	250	179	101
2.	350	242	145

Determine the values of the shear strength parameters in terms of total and effective stresses. If in the consolidated undrained test, an identical specimen is first consolidated under a cell pressure of 400 kN/m^2, what would be the deviator stress at failure?

2. Borings at a site show the following subsurface condition:

Depths	Material	Properties
0 to 2m	Silt	ρ = 1.44 gm/cc
2m to 12m	Sand	ρ_{sat} = 1.9 gm/cc
12m to 18m	clay	ρ_{sat} = 1.78 gm/cc,
		C = 20kN/m^2, $\emptyset$= 18^0

Ground water table is at a depth of 2m below the ground surface. Estimate the shear strength along a plane at a depth of 16m below the ground surface.

3. Explain Mohr-Coulomb failure criterion.

CO5 Compute the consolidation settlement of foundations and explain the Significance of soil compaction and slope stability analysis

1. A 3m thick clay layer beneath a building is overlain by a permeable stratum and is underlain by an impervious rock. The coefficient of consolidation of the clay was found to be 0.028cm^2/min. The final expected settlement for the layer is 8cm.

i) How much time will it take for 60% of total settlement to take place?

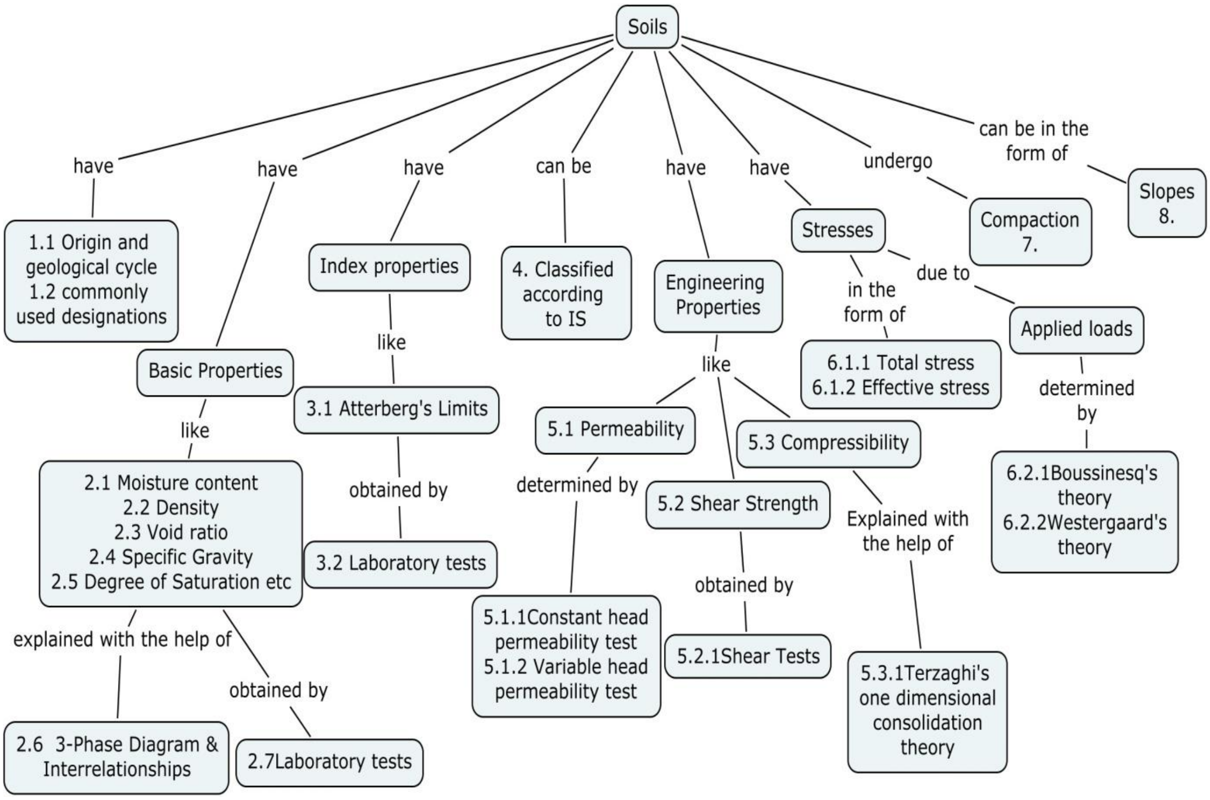
ii) Determine the time required for a settlement of 3.5cm.

iii) What will be the settlement in 8 months?

2. Describe method of slices of slope stability analysis.

3. Calculate the compaction energy in Light and Heavy compaction tests.

Concept Map



Syllabus

Origin and types of soils: Geological cycle - commonly used soil designations. **Physical Properties of soils:** Basic soil properties - 3 Phase Diagram – interrelationships - Laboratory tests for determining basic soil properties - Sieve Analysis including hydrometer Analysis - Field identification of soils. **Consistency limits:** Determination of consistency limits and their significance to the field behavior of soil. **Soil Classification:** AASHTO - Unified Soil Classification System **-** IS Soil classification system. **Permeability:** Darcy's law and its validity - Determination of permeability in laboratory - Factors affecting permeability - Permeability of layered soil deposits - Seepage Analysis – Laplace's equation – Flow Net. **Geostatic Stress:** Concept of Total and Effective Stress in saturated soils deposits - Quick sand condition - Critical hydraulic gradient – Liquefaction. **Stress due to applied loads:** Boussinesq's theory for point load - circular load area and square loaded area - Westergaard's theory for point load - Concept of pressure bulb - Approximate methods - Newmark's influence chart. **Shear Strength:** Shear and normal stress at a point - Mohr's circle of stresses - Mohr's Strength Theory - Mohr-Coulomb failure criterion - Classification of shear test based on drainage conditions - Direct shear test - Unconfined compression test - Triaxial test and Vane Shear test. **Compressibility:** Terzaghi's theory of one dimensional consolidation - Concept of consolidation - Determination of coefficient of consolidation by square root of time method and log time method - Calculation of consolidation settlement. **Soil Compaction:** Concept of Compaction - Standard Proctor and Modified Proctor Compaction Tests - Factors affecting Compaction - Zero air voids curve - Field Compaction control – Compaction methods and Machineries. **Stability of Slopes:** Types of slope failures - Different Factors of safety - Stability Analysis of Infinite and Finite slopes - Taylor's stability number - Stability Analysis by method of slices and "$\emptyset_u$=0" Analysis.

Text Books

1. Dr. Arora. K.R, "Soil Mechanics and Foundation Engineering (Geotechnical Engineering)", Standard Publishers Distributors, Nai Sarak, Delhi, 2011.
2. Gopalranjan and Rao. A.S.R, "Basic and Applied Soil Mechanics", New Age International Publishers, New Delhi, 2014.

Reference Books

1. Braja M. Das, "Fundamentals of Geotechnical Engineering", Cengage; 4th edition, December 2013.
2. Murthy. V.N.S, "Textbook of Soil Mechanics and Foundation Engineering: Geotechnical Engineering ", CBS Publishers and distributors, New Delhi, 2009.
3. Venkatramaiah. C, "Geotechnical Engineering", New Age International (P) Ltd., Publishers, Daryaganj, New Delhi, 2009.
4. Donald P. Coduto, "Geotechnical Engineering – Principles and Practices", Prentice Hall of India (P) Ltd., New Delhi, 2002.

IS Codes

IS: 2720 – Part 1 to Part 40

Course Content and Lecture Schedule

S.No	Topic	No. of Lectures
1.	**Origin and types of soils**	
1.1	Geological cycle	1
1.2	Commonly used soil designations	
2.	**Physical Properties of soils**	
2.1	Basic soil properties	1
2.2	3 Phase Diagram and interrelationships	
2.3	Laboratory tests for determining basic soil properties	1
2.4	Sieve Analysis including hydrometer Analysis	1
2.5	Field identification of soils	
	Tutorial	3

3.	**Consistency Limits**	
3.1	Determination of consistency limits and their significance to the field behavior of soil	1
4.	**Soil Classification**	
4.1	AASHTO system, USCS and IS Soil Classification system	1
	Tutorial	3
5.	**Permeability**	
5.1	Darcy's law and its validity	1
5.2	Determination of permeability in laboratory for cohesive and cohesionless soils	
5.3	Factors affecting permeability	1
5.4	Permeability of layered soil deposits	
5.5	Seepage Analysis, Flow Nets	1
	Tutorial	3
6.	**Geostatic Stress**	
6.1	Concept of Total and Effective Stress in saturated soils deposits	1
6.2	Quick sand condition, Critical Hydraulic Gradient and Liquefaction	1
	Tutorial	3
7.	**Stress due to applied loads**	
7.1	Boussinesq's theory for point load, circular load area and square loaded area	1
7.2	Concept of pressure bulb, Westergaard's theory for point load	1
7.3	Approximate methods	
7.4	Newmark's influence chart	
	Tutorial	3

8.	**Shear Strength**	
8.1	Shear and normal stress at a point	1
8.2	Mohr’s circle of stresses	
8.3	Mohr’s Strength Theory	1
8.4	Mohr-Coulomb failure criterion	
8.5	Classification of shear test based on drainage conditions	
8.6	Direct shear test, Unconfined compression test	1
8.7	Triaxial test and Vane Shear test	1
	Tutorial	3
9.	**Compressibility**	
9.1	Terzaghi’s theory of one dimensional consolidation	1
9.2	concept of consolidation	
9.3	Determination of coefficient of consolidation by square root of time method and log time method	1
9.4	Calculation of consolidation settlement	
	Tutorial	3
10.	**Soil Compaction**	
10.1	Concept of Compaction	1
10.2	Standard Proctor and Modified Proctor Compaction Tests	
10.3	Factors affecting Compaction	
10.4	Zero air voids curve	1
10.5	Field Compaction control, Compaction methods and Machineries	
11.	**Stability of Slopes**	

11.1	Types of slope failures	1
11.2	Different Factors of safety	
11.3	Stability Analysis of Infinite and Finite slopes	1
11.4	Taylor's stability number	1
11.5	Stability Analysis by method of slices	
11.6	"ϕ_u=0" Analysis	
	Tutorial	3
	Total Hours (24+24)	48

Course Designer:

R. Sanjay Kumar sanjaykumar@tce.edu

14CE540 HIGHWAYS AND PAVEMENT ENGINEERING

Category	L	T	P	Credit
PC	2	2	0	3

Preamble

The course aims to make the students learn the principles of highways, their components and design of flexible and rigid pavements. Further, students will get acquainted with treatment for failures and remedial measures during maintenance of pavements.

utcomes

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

		Expected Attainment Level in %	Expected Proficiency Level in grade
CO1: Infer concepts of highway planning and cross sectional elements of pavement	Understand	80	A
CO2: Compute sight distance requirements and design of geometric elements, horizontal profile and vertical profile of a road	Apply Apply	80 80	A A
CO3: Design of flexible pavement components and	Apply	80	A
CO4: Design rigid pavement structure	Understand	80	A
CO5: Describe components of traffic engineering	Apply	80	A
CO6: Infer material properties and procedure for construction of highways and explain appropriate maintenance for the distress			

Mapping with Program Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO 2
CO1	L	---	---	---	---	---	---	---	---	---	---	---	L	---
CO2	S	S	M	M	---	---	---	---	---	---	---	---	M	---
CO3	S	S	S	L	---	L	---	S	---	---	---	---	M	L
CO4	S	S	---	L	---	L	---	S	---	---	---	---	L	L
CO5	M	---	---	---	---	---	---	---	---	---	---	---	L	---
CO6	M	---	L	---	---	L	---	M	M	---	M	---	L	M

Correlation: S-Strong; M-Medium; - L- Low

ent Pattern

Bloom's Category	Continuous Assessment Tests	Terminal Examination

	1	2	3	
Remember	20	20	20	20
Understand	20	20	20	20
Apply	60	60	60	60
Analyse	0	0	0	0
Evaluate	**0**	**0**	**0**	**0**
Create	**0**	**0**	**0**	**0**

evel Assessment Questions

Course Outcome 1 (CO1):

1. State the role of Indian Roads congress in Highway planning.
2. List the obligatory points of highway alignment
3. What are the objectives of central road fund.
4. Explain various cross sectional elements of a rural road.

Course Outcome 2 (CO2):

1. State PIEV theory.
2. Define lag distance and braking distance.
3. Derive the expression for superelevation on curves
4. Calculate OSD required on a two way highway, if the speed of overtaking vehicle are 80 Kmph. Assume average rate of acceleration of 2.1 Kmph/sec. Assume all other data as per IRC. Draw a neat sketch of overtaking zone and show the position of sign post.

Course Outcome 3 (CO3):

4. What is rigidity factor in design of highway pavement? Differentiate between correlation and regression of variables
5. Differentiate Flexible pavements and rigid pavements.
6. Design the flexible pavement for a NH having the following data:
   CBR of subgrade soil = 12%, CBR of aggregate mix = 25%, CBR of WBM coarse = 85%.

   The minimum thickness of bituminous macadam surfacing may be taken as 5cm. The last

   traffic count is 1600 commercial vehicles/day. The growth rate is 8%. The pavement

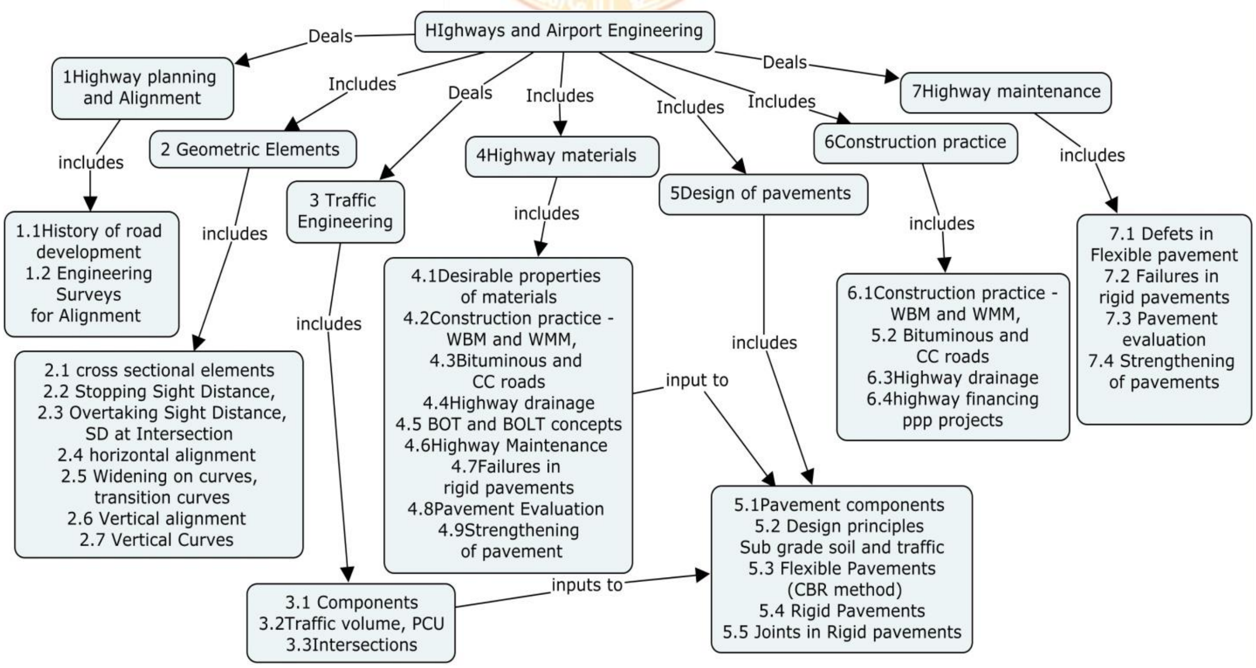
   Construction is to be completed in three years after the last traffic count.

7. Design a cement concrete pavement using the following data and chart.
   Wheel load p=5100kg. Modules of elasticity of cement concrete E= 3×105kg/cm^2 .Poisson's ratio (μ) =0.15. Radius of contact area (a) =15 cm. modules of sub grade reaction K= 15 kg/cm3.Concrete flexural strength fr =40kg/cm^2. Co-efficient of thermal expansion α =10×10-6°C. Temperature variation Δt= 16.4°C. contraction joint spacing L = 4.5m.

Course Outcome 4 (CO4):

1. State the desirable properties of aggregates used in pavements.
2. Explain various failures in rigid pavement and discuss suitable maintenance for failures.
3. Describe the different types of failures in flexible pavements.
4. Discuss the construction procedure for WBM roads.

/lap



Highway planning and Alignment - History of road development in India, Engineering Surveys for Alignment – conventional and modern methods **Geometric Elements** - Geometric Standards - Highway cross sectional elements, Sight Distance, Sight Distance at Intersection, horizontal alignment, transition curves, vertical alignment, Problems in Geometric elements. **Traffic Engineering** – components of traffic engineering, intersections **Highway materials** - Desirable properties of Highway materials **Design of pavements -** pavement components and their functions, Design principles of Flexible and Rigid Pavements, factors affecting design of pavements, Design practice for Flexible Pavements – Problems, Design practice for Rigid Pavements – Problems, Joints in Rigid pavements. **Highway Construction practice -** Water Bound Macadam and Wet mix Macadam road, Bituminous and Cement Concrete roads, construction on soil stabilized subgrade, Highway drainage, Principles of Highway Financing, PPP concepts for Highway constructions. **Highway Maintenance** - Defects in flexible pavements - symptoms, causes and treatments, Failures in rigid pavements – special repairs, Pavement Evaluation – surface and structural Evaluation and strengthening.

ks

1. S.K Khanna, and C E G.Justo and A. Veeraragavan, "Highway Engineering", New Chand and Bros, Roorkee, 10th edition, 2015.

e Books

1. Kadiyali, L.R., "Principles and Practice of Highway Engineering", Khanna Publishers Ltd. New Delhi, 2011.
2. Venkatappa Rao,G, "Principles of Transportation and Highway Engineering", Tata McGraw Hill Publishing Co, Ltd, New Delhi, 2000.
3. Nptel.ac.in/courses/105101087/Lec-12pdf

IS Codes

1. IRC Standards (IRC 37-2012, and IRC 58 – 1998)
2. IRC 73 – 1983 Geometric Design Standards for Rural Roads
3. IRC 86 – 1983 Geometric Design Standards for Urban Roads
4. Bureau of Indian Standards (BIS) Publications on Highway Materials
5. Specifications for Road and Bridges, MORTH (India, 2004)

ontents and Lecture Schedule

S. No.	Topics	No. of Lectures
1	**Highway planning and Alignment**	
1.1	History of road development in India – Jayakar committee recommendations, Vision 2021, NHAI and NHDP policies, PMGSY	1
1.2	Engineering Surveys for Alignment – conventional and modern methods (Remote sensing, GIS and GPS techniques), IRC Classification	1
2	**Geometric Elements**	
2.1	Geometric Standards - Highway cross sectional elements – carriageway, ROW, camber, kerbs, shoulders, footpath, drains	1
2.2	Sight Distance – Factors affecting Sight Distance – PIEV Theory – Stopping Sight Distance (SSD)	1
	Tutorials – problems in SD	3
2.3	Overtaking Sight Distance (OSD) – Sight Distance at Intersection	1
	Tutorials– problems in OSD	3

2.4	horizontal alignment – horizontal curves, Super elevation – derivation, problems, camber – methods of attainment	1
2.5	Widening on curves, transition curves - types	1
	Tutorial – problems in horizontal curves, widening, transition curves	4
2.6	Vertical alignment - Ruling, Limiting, Exceptional and Minimum Gradients	1
2.7	Vertical Curves – types, design, shift in curves	
	Tutorial – problems in vertical curve design	4
3	**Traffic Engineering**	
3.1	Components of traffic engineering	1
3.2	Traffic volume – PCU concept, Intersections – types, at grade and grade separated structures- flow concepts	1
	Tutorial	2
4	**Highway materials**	
4.1	Desirable properties of Highway materials – subgrade soil, CBR	1
4.2	Aggregates, bitumen – types and properties	1
5	**Design of pavements**	
5.1	Pavement components and their functions	1
5.2	Design principles of Flexible and Rigid Pavements, factors affecting design of pavements – ESWL	1
5.3	Sub grade soil and traffic, Design practice for Flexible Pavements	1
	Tutorial – problems in flexible pavement design (CBR method, US corps method)	4
5.4	Design practice for Rigid Pavements	1
5.5	Joints in Rigid pavements - types	1
	Tutorial - problems in rigid pavement design (IRC method)	4
6	**Highway Construction practice**	
6.1	Construction practice - Water Bound Macadam and Wet mix Macadam road	1
6.2	Bituminous and Cement Concrete roads	1
6.3	Highway drainage – importance of drainage systems, types, surface and sub surface drainage systems	1

6.4	Principle of Highway Financing, PPP projects - BOT and BOLT concepts	1
7	**Highway Maintenance**	
7.1	Highway Maintenance - Defects in flexible pavements – surface defects, disintegration – symptoms, causes and treatments	1
7.2	Failures in rigid pavements – special repairs	1
7.3	Pavement Evaluation - Pavement surface conditions	1
7.4	Strengthening of pavement – Benkelman Beam Method	
	Total Hours (24+24)	48

esigners

1. Dr. R. Velkennedy rvkciv@tce.edu

2. Ms. D. Srividya dsciv@tce.edu

14CE570	DESIGN OF MASONRY, TIMBER AND STEEL ELEMENTS	Category	L	T	P	Credit
		PC	2	0	2	3

Preamble

The primary concern of an engineer is design. Structural design consists conceptualization, idealization, analysis, design, construction and maintenance. Conceptualization is required to arrive at the final shape and size of the structure. Idealization involves reducing the conceived structure into primary elements. By analysis internal forces like bending moments, shear, torsion, compression and tension in each and every element is determined. Design assigns every element a particular material and size. Construction involves putting all the elements together to perform like the originally conceived structure. Maintenance is needed to keep the performance of the structure without deterioration.

In this course, designs of structural elements, like beam, walls and columns, made of specific materials like timber, masonry and steel are dealt with. Further the elements are designed for internal forces like tension, compression, bending moment and shear.

Prerequisite

Knowledge of Strength of Materials, Mechanics of Solids and Structural Analysis

Course Outcomes

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

COs for Theory cum practice part:

			Expected Attainment level in %	Expected Proficiency Level in grade
CO1	Classify the types & behaviour, arriving the dimensions and detailing of brick masonry wall & column and also its foundation	Apply	70	A
CO2	Design and detail the timber joists and columns.	Apply	70	A
CO3	Summarize the codal provisions in IS800:2007 for tension members, compression members and connections.	Apply	70	A
CO4	Explain the force transferring mechanism, design and detail the connections as bolted and welded connections.	Apply	70	A

CO5	Design and detail of steel tension members, compression members and flexure members.	Create	70	A
CO6	Design and detail column base.	Create	70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO27.	S	-	M	-	L	M	-	S	M	L	-	-	M	L
CO28.	S	-	M	-	L	M	-	S	M	L	-	-	M	L
CO3	M	-	M	-	L	M	-	S	M	L	L	-	M	M
CO4	M	-	M	-	L	M	-	S	M	L	M	-	M	M
CO5	M	-	M	-	L	M	-	S	M	L	L	-	M	L
CO6	M	-	M	-	L	M	-	S	M	L	L	-	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Theory cum Practice Part:

Assessment	Test-1		Test-2		Test-3		End semester	
	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Remember	10	-	10	-	10	-	10	-
Understand	10	-	10	-	10	-	10	-
Apply	50	30	50	30	50	30	50	30
Analysis	-	-	-	-	-	-	-	-
Evaluate	-	-	-	-	-	-	-	-
Create	-	-	-	-	-	-	-	-
Total	70	30	70	30	70	30	70	30
Duration of Exam	**Two hours**		**Two hours**		**Two hours**		**Four hours**	

Course Level Assessment Questions (Theory Part)

Course Outcome 1 (CO1):

1. Estimate the dimension of an interior cross wall of a two storeyed building shown in figure-1 to carry 100mm thick RCC slab with 3.0m ceiling height. The wall is unstiffened and it supports a 2.5m wide slab.

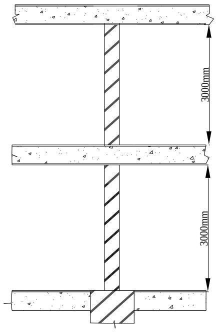


Figure-1

2. Design and detail of an exterior wall of a workshop building 3.5m high carrying steel trusses at the top at 4.5m spacing. The wall is securely tied at the roof and floor level. The loading shall be assumed as following:
   Concentrated reaction from the roof trusses – 25kN acting at the centre of the wall

   Roof loading – 7kN/m. Ignore wind load

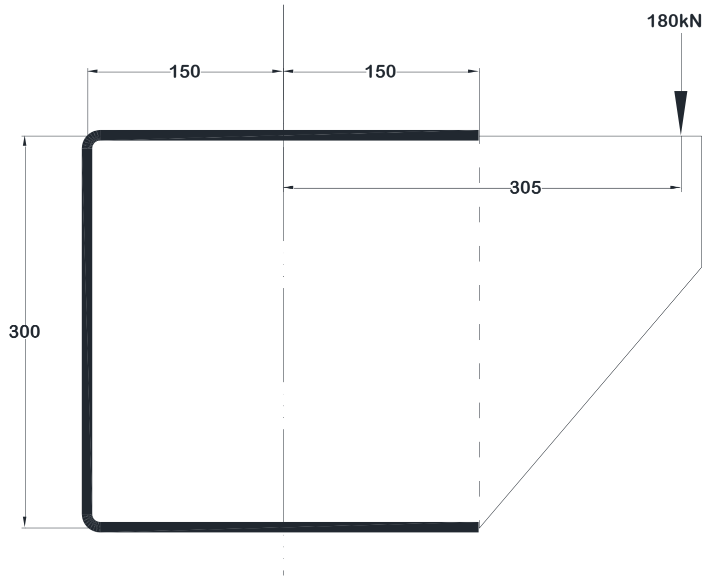
3. Under what circumstances the cavity walls are preferred?

Course Outcome 2 (CO2):

1. A solid timber beam, 75 mm wide × 250 mm deep, in strength class C16, 3.4 m simply supported, supports uniformly distributed permanent (including self-weight of beam) and variable actions of respectively 0.2 kN/m and 2 kN/m. Assuming the beam is torsionally restrained at supports and the exposure is service class 2 check its bending capacity.
2. A mechanically graded timber column of strength class C16 consists of a 100 mm square section which is restrained at both ends in position but not in direction. Assuming that the service conditions comply with Service Class 2 and the actual height of the column is 3.75m, calculate the design axial long term load that the column can support.
3. A timber tension member of size 80mm x 160mm is spliced by two 40mm x 160mm fish plates and 4 nos. of 20mm dia. bolts. Determine the maximum load that can be carried by the spliced member. The members are composed of class A timber.for which fcp = 12N/mm2 and ft =18.2 N/mm2

Course Outcome 3 (CO3):

1. A bolted shell is made up of 14mm thick plates. The joint is double bolted lap joint with M22 bolt of grade 4.6 at a pitch of 75mm. Determine in what way the joint will fail? Also calculate the efficiency of the joint.
2. A tie bar in a bridge consists of flat bar of steel Fe410 grade, 200mm wide 10mm thick. It is to be spliced by a double cover butt joint using M20 bolt of 4.6 grade. Design the joint and sketch the arrangement of bolts.
3. A bracket plate is welded to the flange of a column as shown below. Calculate the size of the weld required to support a factored load of 100kN.



Course Outcome 4 (CO4):

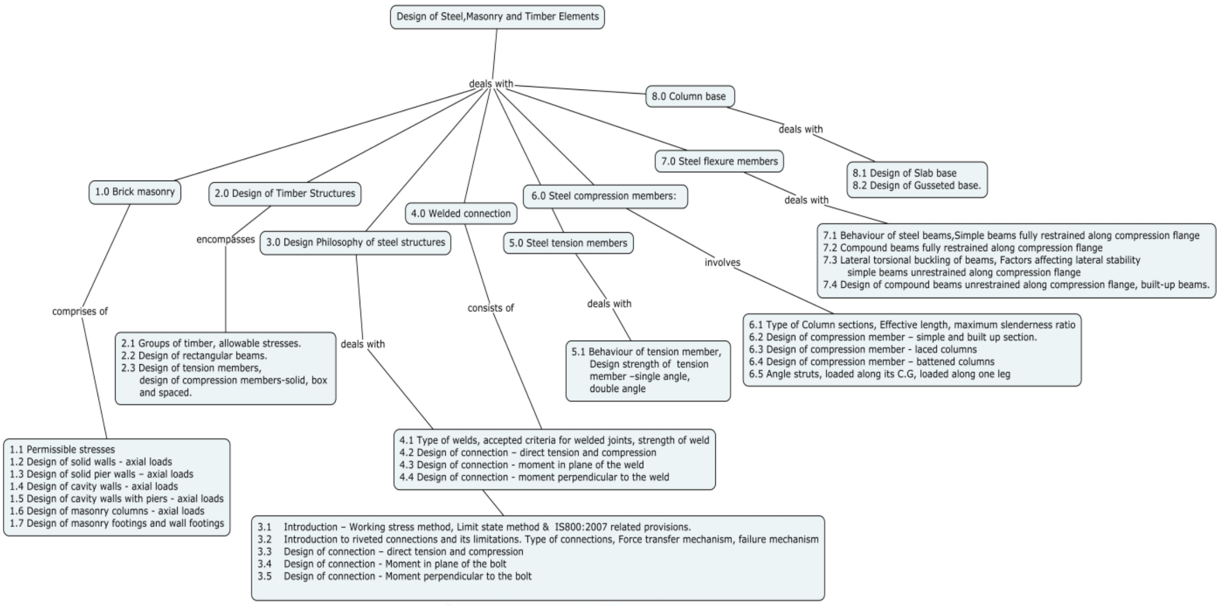
1. A single unequal angle 100x75x6mm is connected to 8mm thick gusset plate at the ends with 6 numbers of 16mm bolts of grade 4.6 to transfer tension. Estimate the design strength of the angle assuming that the yield and the ultimate stress of steel used are 250Mpa and 410Mpa,
   if the gusset plate is connected to the 100mm leg

   if the gusset plate is connected to the 75mm leg
2. A double angle discontinuous strut ISA 125 mm x 95 x mm x10 mm longlegs back to back is connected to both sides of a gusset plate 10 mm thickwith 2 rivets. The length of strut between centre-to-centre of intersections is 4m. Determine the safe load carrying capacity of the section.
3. Design rolled steel I- sections for a simply supported beam with a clear span of 6m .it carries a UDL of 50 KN per metre exclusive of self-weight of the girder The beam is laterally unsupported.

Course Outcome 5 (CO5):

1. A built up column consists ISHB 400@ 77.40 kg/m with one 300mm x 12mmflange plate on each side. The column carries an axial load of 2600kN. Design a gusseted base, if the column is supported on concrete pedestal with a bearing pressure of 5N/mm2.
2. A column of ISMB 400 is subjected to an axial force of 750kn. Design suitable base plate. Assume necessary data required.
3. What are the functions of providing column bases?

Concept Map



Syllabus

Brick masonry: Design - solid masonry walls, cavity walls - piers / columns - under axial loads - masonry wall footings - column footings. **Design of Timber Structures:** Groups of timber - Design - rectangular beams - tension members - compression members - solid, box and spaced. **Design Philosophy of steel structures:** Introduction – Working stress method – Limit state method – IS800:2007 related provisions. **Bolted connection in steel structures:** Connection types - Introduction to riveted connections - Force transfer mechanism of bearing type & HSFG bolts- failure mechanism - Design - direct tension - compression - moment in plane of the bolt - moment perpendicular to the bolt. **Welded connection in steel structures:** Type of welds, joints - strength of welds - Design -direct tension – compression - moment in plane of the weld - moment perpendicular to the weld. **Steel tension members:** Behaviour - Design – Rods – Plate – Single and double angle. **Steel compression members:** Type of Column sections - Design - rolled steel section - built up section - laced and battened columns - Angle struts **Steel flexure members:** Behaviour - Design - simple and compound beams - Laterally restrained – Laterally unrestrained - Factors affecting lateral stability - built-up beams. **Column base:** Slab base - and gusseted base.

Text Book

1. Duggal S.K., “Limit state design of steel structures” McGraw Hill Co., New Delhi, 2014
2. Dayaratnam. P., (1987) “Brick and Reinforced Brick Structures”, Oxford IBH publishing Co .Pvt Ltd,New Delhi.
3. Arya.A.S & Ajmani.J.L.”Design of Steel Structures”, New Chand & Bros.Roorkee.

Reference Books

1. Teaching Resource for Structural Steel Design, Vol. 1,2,3 (2000), INSDAG- Institute for Steel Development and Growth, Kolkatta.
2. Subramanian, N., (2008), Design of Steel Structures, oxford university press, USA,.
3. Negi L.S. “Design of steel structures” McGraw Hill Co., New Delhi, 2014
4. www.nptel.ac.in

Indian Standard Codes

1. IS:1905-1987, Code of Practice for Structural Use of Unreinforced Masonry.

2. IS:2212-1991, Code of Practice for brick work.
3. IS:883-1994, Code of Practice for Design of Structural Timber in Building.
4. IS: 800 – 2007, Code of Practice for general construction in steel, BIS, New Delhi
5. IS: 800 – 1984, Code of Practice for general construction in steel, BIS, New Delhi
6. SP 6 (1) – Structural steel sections
7. IS: 816 - 1969, Code of practice for use of metal arc welding for general construction in mild steel-
8. IS:808 – 1989 Dimensions For Hot Rolled Steel Beam, Column, Channel and Angle Sections.

Course Contents and Lecture Schedule (Theory Part)

Module No.	Topic	No. of Lectures
1.0	**Brick masonry**	
1.1	Permissible stresses	1
1.2	Design of solid walls - axial loads	1
1.3	Design of solid pier walls – axial loads	1
1.4	Design of cavity walls - axial loads	1
1.5	Design of cavity walls with piers - axial loads	1
1.6	Design of masonry columns - axial loads	1
1.7	Design of masonry footings and wall footings	1
2.0	**Design of Timber Structures**	
2.1	Different groups of timber, allowable stresses in tension, compression and flexure	1
2.2	Design of rectangular beams.	
2.3	Design of tension members, design of compression members-solid, box and spaced.	1
3.0	**Design Philosophy of steel structures:**	
3.1	Introduction – Working stress method, Limit state method& IS 800: 2007 related provisions.	
	Bolted connection in steel Structures :	
3.2	Introduction to riveted connections and its limitations. Type of connections, Force transfer mechanism, failure mechanism	1
3.3	Design of connection – direct tension and compression	

3.4	Design of connection - Moment in plane of the bolt	1
3.5	Design of connection - Moment perpendicular to the bolt	1
4.0	**Welded connection in steel structures:**	
4.1	Type of welds, accepted criteria for welded joints, strength of weld	1
4.2	Design of connection – direct tension and compression	
4.3	Design of connection - moment in plane of the weld	1
4.4	Design of connection - moment perpendicular to the weld	1
5.0	**Steel tension members:**	
5.1	Behaviour of tension member, Design strength of tension member –single angle, double angle	1
6.0	**Steel compression members:**	
6.1	Type of Column sections, Effective length, maximum slenderness ratio	
6.2	Design of compression member – rolled steel section – simple and built up section.	1
6.3	Design of compression member - laced columns	
6.4	Design of compression member – battened columns	1
6.5	Angle struts, loaded along its C.G, loaded along one leg	1
7.0	**Steel flexure members**:	
7.1	Behaviour of steel beams, Limit state of serviceability, Design of simple beams fully restrained along compression flange	
7.2	Design of compound beams fully restrained along compression flange	1
7.3	Lateral torsional buckling of beams, Factors affecting lateral stability Design of simple beams unrestrained along compression flange	1
7.4	Design of compound beams unrestrained along compression flange, built-up beams.	1
8.0	**Column base**	

8.1	Design of Slab base	1
8.2	Design of Gusseted base.	1
	Total Hours	24

List of Exercises for Practical Part

Module No.	Exercise No.	No. of practical hours
1.	Detailing of Masonry wall and wall footing	2
2.	Detailing of Masonry pier and footing	2
3.	Detailing of Timber Joist and timber column	2
4.	Detailing of Bolted Connections – Lap and Butt Joint	2
5.	Detailing of Bolted Connections – Eccentric Connections (In plane and Out of plane)	2
6.	Detailing of Welded Connections – Lap and Butt Joint	2
7.	Detailing of Welded Connections – Eccentric Connections (In plane and Out of plane)	2
.	Detailing of Tension Members – Plate and Angle	2
9.	Detailing of Compression Members – Double symmetry sections	2
10.	Detailing of Compression Members – Angle struts	2
11.	Detailing of slab base and gusetted base	2
12.	Detailing of Flexural Members – Main member / Mezzanine Platform	2
	Total Hours	**24**
Note: Detailing may be done using modern drafting tools / manually		

Course Designers:

1. Dr. S. Arulmary samciv@tce.edu
2. Ms. G.Celine Reena celinereena@tce.edu

14CE580 MATERIALS TESTING LAB

Preamble

Category	L	T	P	Credit
PC	0	0	2	1

This laboratory course work is intended to provide students with opportunities to acquire knowledge and to develop skills in testing different materials used for the construction of building under the action of various forces and determining their characteristics experimentally. The experimental work involved in this laboratory will make the student to determine the mechanical and physical properties of materials like steel, wood, aluminium, cement, fine and coarse aggregate, etc. The students will be able to infer the suitability of these materials for construction. They can design the mix, make the specimens and test the same for the strength for comparison with design strength. This laboratory course will help the students to understand the theoretical concepts learned in the courses strength of materials and concrete technology.

Prerequisite

Fundamentals of Mathematics, strength of materials and concrete technology

Course Outcomes

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

			Expected Attainment level in %	Expected Proficiency Level in grade
CO1	Determine the behavior of structural elements, such as bars, beams and springs subjected to tension, compression, shear, bending, and torsion by means of experiments	Apply	95	S
CO2	Determine the physical properties of constituent materials of concrete	Apply	95	S
CO3	Determine the properties of fresh concrete	Apply	95	S
CO4	Determine the properties of hardened concrete	Apply	95	S
CO5	Design concrete mixes and apply statistical quality control techniques to concrete quality	Apply	95	S
CO6	Determine durability of concrete	Apply	95	S

with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO35	M	S	S	L	--	L	--	M	L	M	M	L	M	--
CO36	M	S	S	L	--	L	--	M	L	M	M	L	M	--
CO37	M	S	S	L	--	L	--	M	L	M	M	L	M	--
CO38	M	S	S	M	--	L	--	M	L	M	M	L	M	--
CO39	M	S	S	M	--	L	--	M	L	M	M	L	M	--
CO40	M	S	S	M	--	L	--	M	L	M	M	L	M	--

S- Strong; M-Medium; L-Low

List of Experiments

1. Determination of Young's Modulus by conducting Tension Test (mild steel)
2. Determination of Young's Modulus by conducting Deflection Test on wooden/steel/ aluminium members

3. Determination of Rigidity Modulus by conducting Torsion Test on cast iron
4. Determination of Young's Modulus by conducting Bending Test I (verification of Maxwell's Reciprocal Theorem) and Bending Test II (using Huggenberger Tensometer)
5. Determination of Rigidity Modulus by conducting Spring Test (tension and compression spring)
6. Determination of Shear strength and Hardness Number (mild steel, aluminium and copper)
7. Determination of consistency and setting time of cement
8. Determination of bulk density, specific gravity, void ratio, fineness modulus of fine and coarse aggregates
9. Determination of maximum bulk of fine aggregate
10. Determination of workability of concrete by slump test and casting of specimens
11. Determination of workability of concrete by compaction factor test and casting of specimens
12. Design of concrete mix by IS method and casting of specimens

Demonstration

1. Determination of Energy Absorption by conducting Impact Test
2. Test on hardened concrete (cube compressive strength, split cylinder test, flexure test, rebound hammer test and ultrasonic pulse velocity test)
3. Determination of elastic modulus of concrete
4. Durability Tests of concrete

Reference Books

7. Bansal, R.K., "A Text Book of Strength of Materials", Laxmi Publications (P) Ltd. New Delhi 2010
8. James M. Gere and Stephen P. Timoshenko, "Mechanics of Materials" (3rd edition), McGraw Hill Book Company, Singapore, 2002.
9. Varghese.P.C, "Building Materials", PHI Learning Pvt. Ltd, New Delhi, 2012.
10. Shetty, M.S., "Concrete Technology (Theory and Practice)", S. Chand and Company Ltd., New Delhi, 2008.
11. Gambhir, M.L., "Concrete Technology", 3rd Edition, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2004
12. Nevile, "Properties of Concrete", Longman Publishers, 2004.

IS Codes

13. IS 1608 : 1995 Mechanical testing of metals - Tensile Testing
14. IS 4031 : Part 4 : 1988 Methods of physical tests for hydraulic cement: Part 4 Determination of consistency of standard cement paste
15. IS 4031 : Part 5 : 1988 Methods of physical tests for hydraulic cement: Part 5 Determination of initial and final setting times
16. IS 4031 : Part 11 : 1988 Methods of physical tests for hydraulic cement: Part 11 Determination of density
17. IS: 383 – 1970, Specification for Coarse and Fine aggregates from natural sources for concrete
18. IS: 2386 (III) : 1997, Methods of Test for aggregates for concrete
19. IS: 2386 (IV) : 1997, Methods of Test for aggregates for concrete
20. IS 5816 : 1999, Splitting Tensile Strength of concrete – Method of Test
21. IS: 456 : 2000, Plain and Reinforced concrete – code of practice
22. IS: 10262 : 2009, Recommended guidelines for Concrete Mix Design
23. IS: 516 – 1959, Methods of tests for strength of concrete

Course Designers

Dr. K. Sudalaimani	ksudalaimani@tce.edu
Dr. M.C. Sundarraja	mcsciv@tce.edu

14CE590 **ENVIRONMENTAL ENGINEERING LAB**

Category	L	T	P	Credit
PC	0	0	2	1

Preamble

This laboratory course work is intended to impart hands on training in evaluating the water quality parameters, wastewater characteristics and ambient air quality status measurements. This will form the basic input data for arriving at a solution/treatment for upkeep of the environment and promoting public health.

Prerequisite

Fundamentals of Mathematics, Water supply Engineering, Wastewater Engineering

Course Outcomes

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

			Expected Attainment level in %	Expected Proficiency Level in grade
CO1	Conduct experiments to find optimum coagulant dosage for turbidity removal from surface water samples	Apply	95	S
CO2	Fix the chlorine dosage needed for the effective disinfection of water	Apply	95	S
CO3	Obtain the correct dosage of lime and soda needed for the removal of hardness from water.	Apply	95	S
CO4	Fix the chemical characteristics of Water from different sources.	Apply	95	S
CO5	Fix the chemical characteristics of Wastewater of different sources.	Apply	95	S
CO6	Measure the ambient air quality parameters such as Particulate Matter, NOx and SO_2	Apply	95	S

with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO41	S	S	M	S	-	S	M	--	M	M	-	-	M	L
CO42	S	S	M	S	-	S	M	--	M	M	-	-	M	L
CO43	S	S	M	S	-	S	M	--	M	M	-	-	M	L
CO44	S	S	S	S	-	S	S	-	M	M	--	--	M	L
CO45	S	S	S	S	-	S	S	-	M	M	--	--	M	L
CO46	S	S	M	S	-	S	S	-	M	M	-	-	M	L

S- Strong; M-Medium; L-Low

List of Experiments

13. Determination of Hardness, Alkalinity and Chlorides in water sample.
14. Determination of Fluorides in drinking water – Spectro photometric analysis.
15. Determination of Sulphate in water sample – Turbiditymetric analysis.
16. Determination of Dissolved oxygen in drinking water.
17. Heavy metal measurement using AAS.
18. Optimum coagulant dosage for removal of turbidity in water.
19. Estimation of chlorine dosage for disinfection of water.

20. Determination of Total solids, suspended solids, Dissolved solids, Organic solids, Inorganic solids in water and wastewater samples.
21. Determination of Nitrates in water and wastewater – Spectro photometric analysis.
22. Determination of COD of wastewater samples.
23. Determination of Oil and greasy matters in wastewater samples.
24. Determination of Ammonia nitrogen in wastewater samples.
25. Determination of Phosphate in wastewater samples.
26. Measurement of Ambient air quality parameters – Particulate Matter, SO_2, NOx

Demonstration

5. Determination of pH of water and wastewater.
6. Determination of BOD of wastewater.
7. Characterization of municipal solid waste and volatile component Estimation.

Reference Books

1. American Public Health Association (APHA) 2005, Standard methods for the examination of water & wastewater. 21st edition, Eaton, A.D., Clesceri, L.S., Rice, E.W., Greenberg, A.E., Franson, M.A.H. APHA, Washington.

IS Codes

24. IS 3025 : Part 21 : 2009 Methods of sampling and test (Physical and Chemical) for water and wastewater : Hardness
25. IS 3025 : Part 23 : 1986 Methods of sampling and test (Physical and Chemical) for water and wastewater : Alkalinity
26. IS 3025 : Part 32 : 1988 Methods of sampling and test (Physical and Chemical) for water and wastewater : Chloride
27. IS 3025 : Part 34 : 1988 Methods of sampling and test (Physical and Chemical) for water and wastewater : Nitrate
28. IS 3025 : Part 24 : 1986 Methods of sampling and test (Physical and Chemical) for water and wastewater : Sulphate
29. IS 3025 : Part 60 : 2008 Methods of sampling and test (Physical and Chemical) for water and wastewater : Fluoride
30. IS 3025 : Part 10 : 1984 Methods of sampling and test (Physical and Chemical) for water and wastewater : Turbidity
31. IS 3025 : Part 16 : 1984 Methods of sampling and test (Physical and Chemical) for water and wastewater : FILTERABLE RESIDUE (TOTAL DISSOLVED SOLIDS)
32. IS 3025 : Part 11 : 1983 Methods of sampling and test (Physical and Chemical) for water and wastewater : pH VALUE
33. IS 3025 : Part 44 : 1993 Methods of sampling and test (Physical and Chemical) for water and wastewater : BIOCHEMICAL OXYGEN DEMAND (BOD)
34. IS 3025 : Part 39 : 1989 Methods of sampling and test (Physical and Chemical) for water and wastewater : Oil and Grease
35. IS 3025 : Part 58 : 2006 Methods of sampling and test (Physical and Chemical) for water and wastewater : CHEMICAL OXYGEN DEMAND (COD)
36. IS 3025 : Part 31 : 1988 Methods of sampling and test (Physical and Chemical) for water and wastewater : Phosphorous
37. IS 5182 : Part 2 : 2001 Methods for Measurement of Air Pollution : Sulphur dioxide
38. IS 5182 : Part 6 : 2006 Methods for Measurement of Air Pollution : Oxides of Nirogen
39. IS 5182 : Part 23 : 2001 Methods for measurement of air pollution : Respirable Suspended Particulate Matter (PM_{10}) cyclonic flow technique

Course Designers

Dr. T. VelRajan	tvciv@tce.edu
Dr. D.P. Vijayalakshmi	dpviji@tce.edu

14CE610	DESIGN OF REINFORCED CONCRETE ELEMENTS	Category	L	T	P	Credit
		PC	2	2	0	3

Preamble

The design of modern reinforced concrete structures may appear to be highly complex. However, most of these structures are the assembly of several basic structural elements such as beams, columns, slabs, walls and foundations. Accordingly, the designer has to learn the design of these basic reinforced concrete elements. This course offers the design of reinforced concrete elements such as beams, slabs, columns and footings using Limit State Method. This course follows the recommendations of IS 456:2000. It aims at determination of safe as well as economical sections and their reinforcements under various types of load combinations. At the end of this course, students will be able to identify and apply the design codes relevant to the design of reinforced concrete members and also they will be familiar with professional and ethical issues and the importance of lifelong learning in structural engineering.

Prerequisite

Knowledge of Mathematics, Strength of Materials 14CE220 and Structural Analysis 14CE420

Course Outcomes

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

	On the successful completion of the course, students will be able to		Expected attainment level (%)	Expected proficiency level (grade)
CO1	Explain the design concepts of RC structural elements under various forces and interpret IS codal provisions	Apply	80	S
CO2	Design the beam and slab elements under flexure, and draw the reinforcement details	Apply	80	S
CO3	Design the beam and slab elements under shear and torsion, anchorage and development length and draw the reinforcement details	Apply	80	S
CO4	Design the column element under compression and draw the reinforcement details	Apply	80	S
CO5	Check the serviceability requirements for RC elements under deflection and cracking	Apply	80	S
CO6	Design the footing and draw the reinforcement details	Apply	80	S

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1.	S	M	S	-	-	-	M	M	M	S	-	-	M	-
CO2.	S	M	S	-	-	-	M	M	M	S	-	-	M	-
CO3.	S	M	S	-	-	-	M	M	M	S	-	-	M	-
CO4.	S	M	S	-	-	-	M	M	M	S	-	-	M	-
CO5.	S	M	S	-	-	-	M	M	M	S	-	-	M	-
CO6.	S	M	S	-	-	-	M	M	M	S	-	-	M	-

S- Strong; M-Medium; L-Low

Assessment Pattern:

Assessment	Test – I	Test – II	Test – III	End Semester
Remember	5	5	10	10
Understand	5	5	10	10
Apply	40	40	80	80
Analysis	--	--	--	--
Evaluate	--	--	--	--
Create	--	--	--	--
Total	50	50	100	100

Course Level Assessment Questions

CO1: Explain the design concepts of structural elements under various forces and interpret IS codal provisions

1. Explain the differences between working stress method and limit state method.
2. What are the limit states?
3. Define the term characteristic strength of materials.
4. What are the advantages of limit state method over other methods?
5. What is partial safety factor?
6. What is the cover for the structural elements as per IS code against durability and fire resistance.
7. Explain the stress-strain behavior of steel and find the stress and strain at various stress levels for Fe415 and Fe500 grade steels.

CO2: Design the beam and slab elements under flexure and draw the reinforcement details

1. Write short notes on balanced, under reinforced and over reinforced sections.
2. Under what circumstances the doubly reinforced section is designed?
3. What is the minimum reinforcement requirement for beam as per IS 456:2000.
4. What is the nominal reinforcement to be used in slab?
5. Compute the position of the neutral axis of a reinforced concrete beam 150mm wide and 400mm deep (effective). Area of tensile steel is 804mm^2. Use M20 and Fe415 as materials.
6. Predict the neutral axis of a T beam of effective depth 400mm and flange width 1200mm. Assume slab thickness to be 100mm. Tensile steel consists of four 20mm diameter bars. Take width of web as 200mm. Use M20 grade concrete and Fe415 as materials.

7. A beam 350 x 1000mm effective is reinforced on tension side with 4445mm^2 of steel. On the compression side 2665mm^2 steel is placed 50mm below the top edge. If concrete grade M20 and steel Fe415 are used, compute the moment of resistance of the beam.
8. Calculate the ultimate moment resistance of a T-beam having the following data. Width of flange = 1550mm; breadth of web = 300mm; effective depth of beam = 620mm; depth of flange = 110mm. Area of tension reinforcement = 4775mm^2. Concrete M20 and steel Fe415.
9. Compute the reinforcement required for the rectangular section of size 230mm x 500mm effective subjected to a factored moment of 250 kNm. The materials used in the design are M25 and Fe500. Assume d^1=35mm. Draw the cross section and longitudinal section of the beam showing reinforcement details.
10. Make use of limit state method, design the rectangular beam, which is simply supported at the ends and subjected to a load of 35kN/m over entire length. The effective length of beam is 4m. The beam is constructed with M20 and Fe415 materials. Draw the cross section and longitudinal section of the beam showing reinforcement details.
11. Compute the reinforcement required for a two way slab simply supported on all the four sides with provision of torsion reinforcement at corners. The clear dimension of the room is 4m x 4m. It is supported on 230mm thick wall. Live load on slab is 3 kN/m^2. Use M20 and Fe415 as materials. Draw the longitudinal section of the slab showing reinforcement details.
12. Compute the reinforcement required for a four span one way continuous roof slab of effective span 3.5m subjected to a live load of 3.0 kN/m^2. Consider other dead loads on the slab. Use M20 and Fe415 as materials. Draw the longitudinal section of the slab showing reinforcement details.

CO3: Design the beam element under shear and torsion, anchorage and development length and draw the reinforcement details

1. How the shear stress can be resisted in the beams?
2. How the torsion can be resisted in the case of beams?
3. What is the expression related to beam subjected to combined bending, shear and torsion?
4. An RC beam 250 x 500mm effective carries a load of 20 kN/m (including self weight), over a span of 6m. If the tensile steel is 1%, calculate the shear stress in the beam and shear strength of concrete. Assume concrete M20 is used.
5. Compute the shear reinforcement required for a T-beam having breadth of web as 230mm and effective depth of 500mm subjected to an UDL of 30kN/m. The effective length of beam is 7m. The tension reinforcement is 5 Nos of 16mm diameter bar. Use M20 and Fe415 as materials. Draw the cross section and longitudinal section of the beam showing reinforcement details.
6. Compute the reinforcement required for a circular rectangular beam of size 350mm x 550mm subjected to a bending moment of 140kNm, twisting moment of 18kNm and a shear force of 90kN under ultimate condition. Use M25 grade concrete and Fe415 as materials. Draw the cross section and longitudinal section of the beam showing reinforcement details.
7. An RC beam 230 x 500mm effective has a span of 6m. The beam carries a uniformly distributed load of 60 kN/m including its self weight. Steel at the end of the beam is six 20mm diameter bars at bottom and two 20mm diameter bars at the top of the beam. The beam rests on a support 300mm wide. If M20 and Fe415 are used,

determine the development length required for 20mm diameter bars on tension and compression sides. Draw section of the beam showing reinforcement details.

CO4: Design the column element under compression and draw the reinforcement details

1. What is the minimum diameter of longitudinal bar to be used in column?
2. What are short and long columns?
3. What is the IS specification for finding pitch of lateral ties in column?
4. What is the purpose for providing transverse reinforcement to the column?
5. What is the reason for limiting maximum of 4% reinforcement in columns?
6. Make use of limit state method, design a short circular column 6m long to carry a load of 750kN if both ends of the column are fully restrained, using (i) lateral ties and (ii) helical steel. Draw the cross section and longitudinal section of the column showing reinforcement details.
7. Make use of limit state method, design a column to carry an axial factored load of 2000kN and a factored moment of 50kNm on both the axes. Assume concrete M20 and steel Fe415. Draw the cross section and longitudinal section of the column showing reinforcement details.
8. Make use of limit state method, design a slender circular column of 350mm diameter with the following data. Unsupported length=8m; Effective length=5m; Axial load=500kN; Moment at top=60kNm; Moment at bottom=40kNm. The column bends in double curvature. Use concrete M25 and steel Fe415. Draw the cross section and longitudinal section of the column showing reinforcement details.

CO5: Check the serviceability requirements for RC elements under deflection and cracking

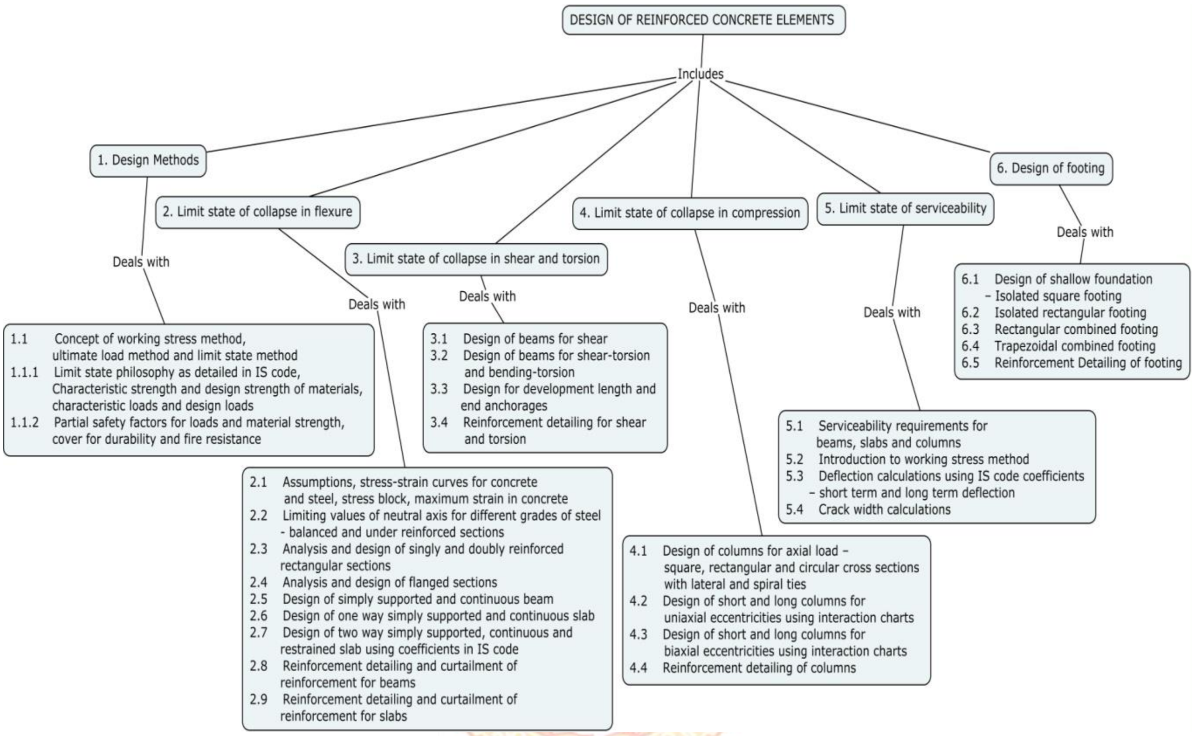
1. What is the IS codal provision for the control of deflection for elements?
2. What is the IS codal equation for determining surface crack width?
3. A simply supported L-beam 5m span has effective flange width of 900mm, thickness of flange as 100mm, breadth of web as 250mm and effective depth as 450mm. there are 4 bars of 22mm in tension and 3 bars of 18mm in compression. Experiment the beam for deflection. Assume M20 grade concrete and Fe415 grade reinforcement.

CO6: Design the footing and draw the reinforcement details

1. What is the IS codal provision for shear in the case of footing?
2. Explain the behavior of rectangular combined footing with reinforcement details.
3. What is the IS codal provision for nominal reinforcement required for footing?
4. Calculate the shear force and bending moment for a rectangular combined footing connecting two axially loaded columns of size 230mm x 230mm and 300mm x 300mm spaced at 2.90m carrying load of 650kN and 750kN under service state respectively. The safe bearing capacity of soil is 200 kN/m^2. Use M20 and Fe415 as materials.
5. Make use of limit state method, design an axially loaded square footing of uniform thickness for a column of size 300mm x 300mm carrying a load of 500kN under working stress condition. The allowable bearing capacity of soil is considered as $230kN/m^2$. Materials: M20 & Fe415. Draw the plan and cross section of the footing showing reinforcement details.
6. Make use of limit state method, design an axially loaded rectangular footing of uniform thickness for a column of size 230mm x 300mm carrying a load of 800kN under working condition. The allowable bearing capacity of soil is considered as

250kN/m^2. Materials: M20 & Fe415. Draw the plan and cross section of the footing showing reinforcement details.

Concept Map



Syllabus

Design Methods – concept of working stress method, ultimate load method and limit state method – Limit state philosophy as detailed in IS code - characteristic strength and design strength of materials, characteristic loads and design loads – partial safety factors for loads and material strength - cover for durability and fire resistance. **Limit state of collapse in flexure** - assumptions – stress-strain curves for concrete and steel – stress block – maximum strain in concrete – limiting values of neutral axis for different grades of steel – balanced and under reinforced sections – analysis and design of singly and doubly reinforced rectangular sections - analysis and design of flanged sections - simply supported and continuous beams - design of one way and two way slabs – simply supported, continuous and restrained – using coefficients in IS code – reinforcement detailing - curtailment of reinforcement. **Limit state of collapse in shear and torsion** – design of beams for shear, shear-torsion and bending-torsion – design for development length and end anchorages – reinforcement detailing. **Limit state of collapse in compression** – design of columns for axial load – square, rectangular and circular cross sections with lateral and spiral ties – design of short and long columns for uniaxial and biaxial eccentricities using interaction charts – reinforcement detailing. **Limit state of serviceability** - serviceability requirements for beams, slabs and columns - Introduction to working stress method – deflection calculations using IS code coefficients – short term and long term deflection – crack width calculations. **Design of footing** – Shallow foundation – Isolated footing – square and rectangular – combined footing – rectangular and trapezoidal – reinforcement detailing.

Text Books

1. B.C. Punmia. Ashok K. Jain and Arun K. Jain, RCC Designs (Reinforced Concrete Structures), Lakshmi Publications (P) Ltd., New Delhi, Ninth Edition, 2012.
2. N. Subramanian, Design of Reinforced Concrete Structures, Oxford University Press, New Delhi, 2014.

Reference Books

1. Unnikrishna Pillai and Devdas Menon, Reinforced Concrete Design (Third Edition), Tata Mc Graw Hill Publishing Company Ltd., New Delhi, 2009.
2. P.C. Varghese, Limit State Design of Reinforced Concrete, Prentice Hall of India, Pvt. Ltd., New Delhi, 2002.
3. M.L. Gambhir, Fundamentals of Reinforced Concrete Design, Prentice Hall of India Private Limited, New Delhi, 2006.
4. N. Krishna Raju and R.N. Pranesh, Reinforced Concrete Design IS 456-2000, Principles and practice, New Age International (P) Ltd Publishers, New Delhi, 2006.
5. S.N. Sinha, Reinforced Concrete Design, Tata McGraw-Hill, New Delhi, 2002.
6. N.C. Sinha and S.K Roy, Fundamentals of Reinforced Concrete, S. Chand & Company Ltd, New Delhi, 2007.
7. Edward G. Nawy, Reinforced Concrete – A fundamental Approach, 6th Edition, Prentice Hall, 2008.
8. Self learning materials – Online courses - http://www.nptel.iitm.ac.in/

IS Codes

1. IS 456:2000 Plain and Reinforced Concrete – Code of Practice.
2. IS 875(1-5):1987 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures.
3. SP 16:1980 Design Aids for Reinforced Concrete to IS 456:1978.
4. SP 34:1987 Handbook of concrete reinforcement and detailing.
5. Handbook for Limit State Design of Reinforced Concrete Structures – Roorkee.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.0	**Design Methods**	
1.1	Concept of working stress method, ultimate load method and limit state method	1
1.2	Limit state philosophy as detailed in IS code, Characteristic strength and design strength of materials, characteristic loads and design loads	1
1.3	Partial safety factors for loads and material strength, cover for durability and fire resistance	1
2.0	**Limit state of collapse in flexure**	
2.1	Assumptions, stress-strain curves for concrete and steel, stress block, maximum strain in concrete	1
2.2	Limiting values of neutral axis for different grades of steel - balanced and under reinforced sections	1
2.3	Analysis and design of singly and doubly reinforced rectangular sections	1
2.4	Analysis and design of flanged sections	1
	Tutorial – Design Problem	2
2.5	Design of simply supported and continuous beam	1
	Tutorial – Design Problem	2
2.6	Design of one way simply supported and continuous slab	1
	Tutorial – Design Problem	2
2.7	Design of two way simply supported, continuous and restrained	1

	slab using coefficients in IS code	
	Tutorial – Design Problem	2
2.8	Reinforcement detailing and curtailment of reinforcement for beams and slabs	1
3. 0	**Limit state of collapse in shear and torsion**	
3.1	Design of beams for shear, shear-torsion and bending-torsion	1
3.2	Design for development length and end anchorages	1
	Tutorial – Design Problem	4
3.3	Reinforcement detailing for shear and torsion	1
4.0	**Limit state of collapse in compression**	
4.1	Design of columns for axial load – square, rectangular and circular cross sections with lateral and spiral ties	1
	Tutorial – Design Problem	2
4.2	Design of short and long columns for uniaxial eccentricities using interaction charts	1
4.3	Design of short and long columns for biaxial eccentricities using interaction charts	1
	Tutorial – Design Problem	2
4.4	Reinforcement detailing of columns	1
5. 0	**Limit state of serviceability**	
5.1	Deflection calculations using IS code coefficients – short term and long term deflection	1
5.2	Crack width calculations	1
	Tutorial – Design Problem	2
6. 0	**Design of footing**	
6.1	Design of shallow foundation – Isolated square and rectangular footing	1
	Tutorial – Design Problem	2
6.2	Rectangular combined footing	1
	Tutorial – Design Problem	2
6.3	Trapezoidal combined footing	1
	Tutorial – Design Problem	2
6.4	Reinforcement Detailing of footing	1
	TOTAL	**48**

Course Designers

Dr. K. Arunachalam karcivil@tce.edu

Dr. M.C. Sundarraja mcsciv@tce.edu

Mr. R. Rajkumar rajkumarcivil@tce.edu

14CE620 **RAILWAYS, AIRWAYS AND WATERWAYS**

Category	L	T	P	Credit
PC	3	0	0	3

Preamble

This course imparts the student's knowledge of planning, design, construction and maintenance of railway tracks. The students acquire proficiency in the application of modern techniques such as GIS, GPS and remote sensing in Railway Engineering. The student develops skills on airport planning and design with the prime focus on runway and taxiway geometrics. Students become conversant with the definition, purpose, location and materials of coastal structures such as piers, breakwaters, wharves, jetties, quays and fenders. The students acquire knowledge on site reconnaissance for location and planning of harbours.

Prerequisite

Nil

Course Outcomes

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

		Expected Attainment level (%)	**Expected proficiency level (grade)**
CO1: Design various geometric elements of railway track	Apply	80	S
CO2: Plan various components of railway system and describe construction methods of modern track system	Understand	80	S
CO3: Study the wind data and prepare runway orientation	Apply	80	S
CO4: Design runway and taxiway geometrics for an airport	Apply	80	S
CO5: Explain the factors required for site selection for a harbour	Understand	80	S
CO6: Apply knowledge on planning of components of docks and harbours to suggest a appropriate layout	Apply	80	S

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO29.	S	M	M	---	---	---	---	L	---	---	---	--	M	---
CO30.	L	---	---	---	---	L	---	---	---	---	---	--	L	---
CO3.	S	L	S	---	---	---	---	L	---	---	---	---	L	---
CO4.	S	M	S	---	---	---	---	L	---	---	---	---	L	---

CO5.	L	---	---	---	---	---	---	---	---	---	---	---	L	---
CO6.	M	---	L	---	---	L	---	---	---	---	---	---	L	---

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination**		
	1	**2**	**3**			
Remember	20	20	20	20		
Understand	30	30	30	30		
Apply	50	50	50	50		
Analyse	-	-	-	-		
Evaluate	-	-	-	-		
Create	-	-	-	-		

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. What is meant by sleeper density? State its importance
2. What is creep? How is it prevented?
3. Write cole's method to determine the number of crossings?
4. List various types of urban transport systems.
5. If a 6^0 curve track diverges from a main curve of 3^0in an opposite direction in the layout of a B.G. yard, calculate the superelevation and the speed on the branch line, if the maximum speed permitted on the main line is 40kmph.

Course Outcome 2 (CO2)

1. State the various methods of plate laying and explain the methods of plate laying widely adopted in India. Mention the interdependence of land use and traffic.
2. Explain the mechanism of interlocking with a help of a neat sketch.
3. Discuss briefly the locations and functions of different types of signals in a layout of railway station.

Course Outcome 3 (CO3)

1. The wind data obtained from on airport site over a period of 4 years are given below. Draw windrose diagram (Type I) to a suitable scale on a graph paper. Determine calm period, the best orientation of runways and the total wind coverage.

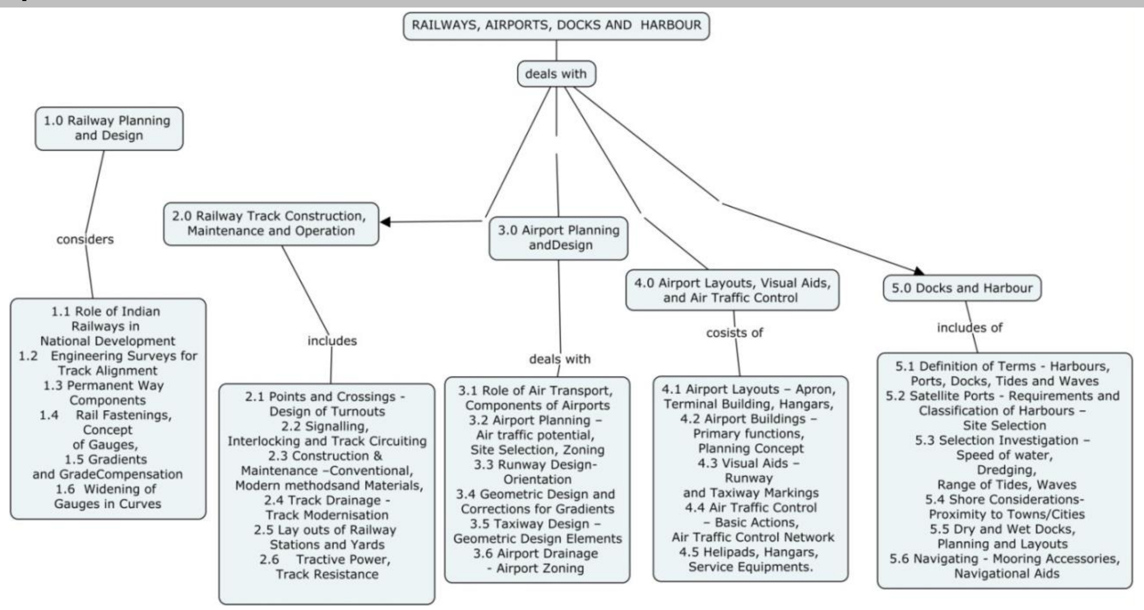
Wind direction	**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**
Total %age of time	7.6	11.3	7.1	3.7	1.5	0.8	0.5	5.1	8.5	15.3	12.5	5.8	3.4	0.6	0.5	4.0

2. A taxiway is to be provided for a supersonic transport which has following characteristics. Determining the turning radius of the taxiway. Wheel base= 35 m. Tread of main loading gear =7.1m.Turning speed = 55kmph. Co-efficient of friction between tire and pavement surface=0.14.
3. Enumerate the various factors to be kept in view in selection of site for airport.

Course Outcome 4 (CO4)

1. Explain the classification of harbours under different heads bringing out the requirements of each.
2. State the differences between a transit shed and warehouse with regard to their purpose and construction.
3. Explain with sketches the various types of breakwater.
4. Classify different types of Repair docks. Explain any one in brief.

Concept Map



Syllabus

Railway Planning and Design Role of Indian Railways in National Development – Railways for Urban Transportation – LRT & MRTS - Engineering Surveys for Track Alignment –Permanent Way- its Components and their Functions: Ballastless Tracks - Geometric Design of Railway Tracks. **Railway Track Construction, Maintenance and Operation** Points and Crossings - Design of Turnouts, Working Principle - Signalling, Interlocking and Track Circuiting, Construction & Maintenance – Conventional, Modern methods Track Drainage, Lay outs of Railway Stations and Yards, Rolling Stock, Tractive Power, Track Resistance, Level Crossings. **Airport Planning and Design** - Role of Air Transport, Components of Airports - Airport Planning, Design of Components, Runway Design - Orientation, Cross wind Component, Wind rose Diagram, Geometric Design, Taxiway, Airport Drainage - Airport Zoning, Clearance over Highways and Railways, Airport Layouts – Apron, Terminal Building, Hangars, Motor Vehicle Parking Area and Circulation Pattern, Case studies of Airport Layouts - Airport Buildings -Planning Concept, Visual Aids, Air Traffic Control. **Docks and Harbour -** Definition of Terms - Harbours, Ports, Docks, Tides and Waves, Littoral Drift, Sounding, Area, Depth, Satellite Ports, Requirements and Classification of Harbours – Site Selection & Selection Investigation – Speed of water, Dredging, Range of Tides, Waves and Tidal Currents, Anchoring Grounds, Geological Characteristics, Shore Considerations - Proximity to Towns/Cities, Utilities, Dry and Wet Docks, Planning and Layouts, Navigating - Mooring Accessories, Navigational Aids – Coastal Structures- Breakwaters, Wharves.

Text Books

1. Saxena S.C and Arora S.P, “Railway Engineering”, 6th Edition, Dhanapat Rai Publications, 2004.
2. Khanna S K, Arora M G and Jain S S, Airport Planning and Design, Nemchand and Brothers, Roorkee, (6th Edition)1999.
3. Oza.H.P. and Oza.G.H., “A course in Docks & Harbour Engineering”. Anand Chartor Publishing House Pvt ltd, Gujarat, 2010.

References

1. Rangwala S.C & K.S. “Railway Engineering”, 14th Edition, Charotar Publications, 2005.
2. Rangwala, Airport Engineering, Charotar Publishing House, 1996.
3. S P Bindra, A Course in Docks and Harbour Engineering, Dhanpat Rai and Sons, New Delhi, 1993.
4. J.S. Mundrey, “A course in Railway Track Engineering”. Tata McGraw Hill, 2000.
5. Agarwal M.M., Railway Engineering, Prabha & Co, New Delhi, 2012.
6. Rao G.V., Airport Engineering, Tata Mc Graw Hill, New Delhi, 1992.
7. Seetharaman, “Dock & Harbour Engineering”, 1st Edition, Umesh Publications, 2008.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.0	**Railway Planning and Design**	
1.1	Role of Indian Railways in National Development – Railways for Urban Transportation – LRT & MRTS	1
1.2	Engineering Surveys for Track Alignment – Obligatory points - Conventional and Modern methods (Remote Sensing, GIS & GPS, EDM and other equipments)	2
1.3	Permanent Way, its Components and their Functions: Rails – Types of Rails	1
1.4	Rail Fastenings, Concept of Gauges, Coning of Wheels, Creeps and kinks, Sleepers – Functions, Materials, Density, Materials, Ballastless tracks	2
	Geometric Design of Railway Tracks	
1.5	Gradients and Grade Compensation, Super-Elevation,	2
1.6	Widening of Gauges in Curves, Transition Curves, Horizontal and Vertical Curves.	2
2.0	**Railway Track Construction, Maintenance and Operation**	
2.1	Points and Crossings - Design of Turnouts, Working Principle	2
2.2	Signalling, Interlocking and Track Circuiting	1
2.3	Construction & Maintenance – Conventional, Modern methods and Materials, Track Drainage - Track Modernisation – Automated maintenance and upgrading, Re-laying of Track	2
2.4	Lay outs of Railway Stations and Yards, Rolling Stock, Tractive Power, Track Resistance, Level Crossings.	1
3.0	**Airport Planning and Design**	
3.1	Role of Air Transport, Components of Airports	2
3.2	Airport Planning – Air traffic potential, Site Selection, Zoning	
3.3	Runway Design- Orientation, Cross wind Component, Wind rose Diagram	2
3.4	Geometric Design and Corrections for Gradients	
3.5	Taxiway Design – Geometric Design Elements, Minimum Separation Distances, Design Speed,	2
3.6	Airport Drainage - Airport Zoning - Clear Zone, Approach Zone, Buffer Zone, Turning Zone, Clearance over Highways and Railways	2
4.0	**Airport Layouts, Visual Aids, and Air Traffic Control**	
4.1	Airport Layouts – Apron, Terminal Building, Hangars, Motor Vehicle Parking Area and Circulation Pattern,	1
4.2	Airport Buildings – Primary functions, Planning Concept, Principles of Passenger Flow, Passenger Facilities	1
4.3	Visual Aids – Runway and Taxiway Markings, Wind Direction Indicators, Runway and Taxiway Lightings	

4.4	Air Traffic Control – Basic Actions, Air Traffic Control Network	1
4.5	Helipads, Hangars, Service Equipments.	
5.0	**Docks and Harbour**	
5.1	Definition of Terms - Harbours, Ports, Docks, Tides and Waves, Littoral Drift, Sounding, Area, Depth	2
5.2	Satellite Ports - Requirements and Classification of Harbours – Site Selection	2
5.3	Selection Investigation – Speed of water, Dredging, Range of Tides, Waves and Tidal Currents, Littoral Transport with Erosion and Deposition	
5.4	Shore Considerations- Proximity to Towns/Cities, Utilities, Construction Materials,	2
5.5	Dry and Wet Docks, Planning and Layouts - Entrance, Position of Light Houses,	
5.6	Navigating - Mooring Accessories, Navigational Aids – Coastal Structures- Breakwaters, Wharves.	2
	TOTAL	**36**

Course Designers:

Dr. R. Velkennedy rvkciv@tce.edu
Ms. D. Srividya dsciv@tce.edu

14CE620	RAILWAYS, AIRWAYS AND WATERWAYS	Category	L	T	P	Credit
		PC	3	0	0	3

Preamble

This course imparts the student's knowledge of planning, design, construction and maintenance of railway tracks. The students acquire proficiency in the application of modern techniques such as GIS, GPS and remote sensing in Railway Engineering. The student develops skills on airport planning and design with the prime focus on runway and taxiway geometrics. Students become conversant with the definition, purpose, location and materials of coastal structures such as piers, breakwaters, wharves, jetties, quays and fenders. The students acquire knowledge on site reconnaissance for location and planning of harbours.

Prerequisite

Nil

Course Outcomes

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

		Expected Attainment level (%)	**Expected proficiency level (grade)**
CO1: Design various geometric elements of railway track	Apply	80	S
CO2: Plan various components of railway system and describe construction methods of modern track system	Understand	80	S
CO3: Study the wind data and prepare runway orientation	Apply	80	S
CO4: Design runway and taxiway geometrics for an airport	Apply	80	S
CO5: Explain the factors required for site selection for a harbour	Understand	80	S
CO6: Apply knowledge on planning of components of docks and harbours to suggest a appropriate layout	Apply	80	S

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO31.	S	M	M	---	---	---	---	L	---	---	---	--	M	---
CO32.	L	---	---	---	---	L	---	---	---	---	---	--	L	---
CO3.	S	L	S	---	---	---	---	L	---	---	---	---	L	---
CO4.	S	M	S	---	---	---	---	L	---	---	---	---	L	---

CO5.	L	---	---	---	---	---	---	---	---	---	---	---	L	---
CO6.	M	---	L	---	---	L	---	---	---	---	---	---	L	---

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination		
	1	2	3			
Remember	20	20	20	20		
Understand	30	30	30	30		
Apply	50	50	50	50		
Analyse	-	-	-	-		
Evaluate	-	-	-	-		
Create	-	-	-	-		

Course Level Assessment Questions

Course Outcome 1 (CO1)

6. What is meant by sleeper density? State its importance
7. What is creep? How is it prevented?
8. Write cole's method to determine the number of crossings?
9. List various types of urban transport systems.
10. If a 6^0 curve track diverges from a main curve of 3^0in an opposite direction in the layout of a B.G. yard, calculate the superelevation and the speed on the branch line, if the maximum speed permitted on the main line is 40kmph.

Course Outcome 2 (CO2)

4. State the various methods of plate laying and explain the methods of plate laying widely adopted in India. Mention the interdependence of land use and traffic.
5. Explain the mechanism of interlocking with a help of a neat sketch.
6. Discuss briefly the locations and functions of different types of signals in a layout of railway station.

Course Outcome 3 (CO3)

1. The wind data obtained from on airport site over a period of 4 years are given below. Draw windrose diagram (Type I) to a suitable scale on a graph paper. Determine calm period, the best orientation of runways and the total wind coverage.

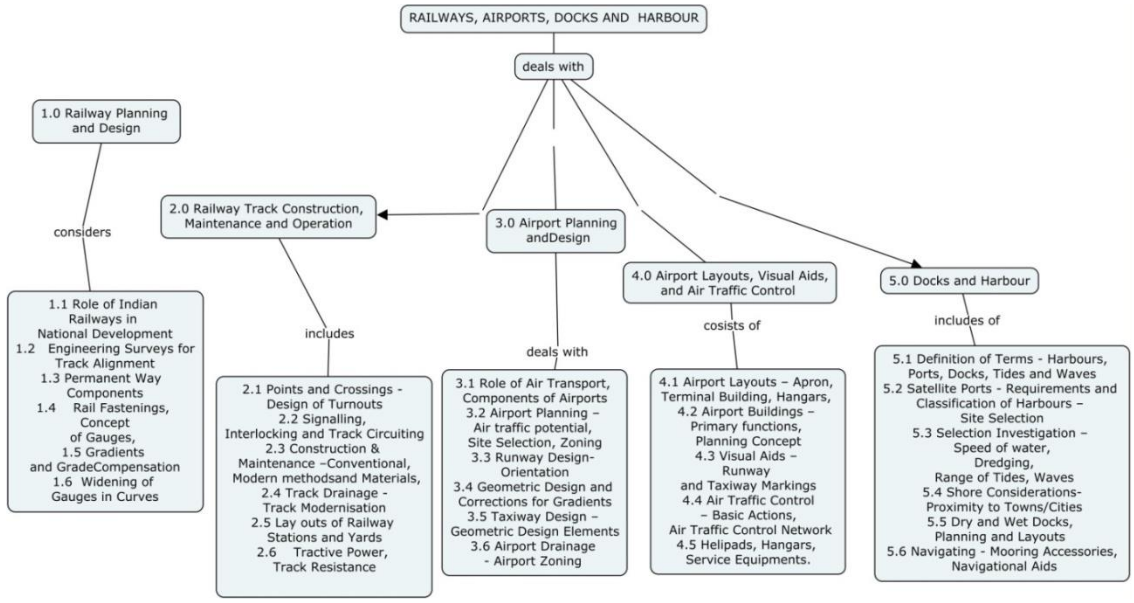
Wind direction	**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**
Total %age of time	7.6	11.3	7.1	3.7	1.5	0.8	0.5	5.1	8.5	15.3	12.5	5.8	3.4	0.6	0.5	4.0

2. A taxiway is to be provided for a supersonic transport which has following characteristics. Determining the turning radius of the taxiway. Wheel base= 35 m. Tread of main loading gear =7.1m.Turning speed = 55kmph. Co-efficient of friction between tire and pavement surface=0.14.
3. Enumerate the various factors to be kept in view in selection of site for airport.

Course Outcome 4 (CO4)

5. Explain the classification of harbours under different heads bringing out the requirements of each.
6. State the differences between a transit shed and warehouse with regard to their purpose and construction.
7. Explain with sketches the various types of breakwater.
8. Classify different types of Repair docks. Explain any one in brief.

Concept Map



Syllabus

Railway Planning and Design Role of Indian Railways in National Development – Railways for Urban Transportation – LRT & MRTS - Engineering Surveys for Track Alignment –Permanent Way- its Components and their Functions: Ballastless Tracks - Geometric Design of Railway Tracks. **Railway Track Construction, Maintenance and Operation** Points and Crossings - Design of Turnouts, Working Principle - Signalling, Interlocking and Track Circuiting, Construction & Maintenance – Conventional, Modern methods Track Drainage, Lay outs of Railway Stations and Yards, Rolling Stock, Tractive Power, Track Resistance, Level Crossings. **Airport Planning and Design** - Role of Air Transport, Components of Airports - Airport Planning, Design of Components, Runway Design - Orientation, Cross wind Component, Wind rose Diagram, Geometric Design, Taxiway, Airport Drainage - Airport Zoning, Clearance over Highways and Railways, Airport Layouts – Apron, Terminal Building, Hangars, Motor Vehicle Parking Area and Circulation Pattern, Case studies of Airport Layouts - Airport Buildings -Planning Concept, Visual Aids, Air Traffic Control. **Docks and Harbour -** Definition of Terms - Harbours, Ports, Docks, Tides and Waves, Littoral Drift, Sounding, Area, Depth, Satellite Ports, Requirements and Classification of Harbours – Site Selection & Selection Investigation – Speed of water, Dredging, Range of Tides, Waves and Tidal Currents, Anchoring Grounds, Geological Characteristics, Shore Considerations - Proximity to Towns/Cities, Utilities, Dry and Wet Docks, Planning and Layouts, Navigating - Mooring Accessories, Navigational Aids – Coastal Structures- Breakwaters, Wharves.

Text Books

1. Saxena S.C and Arora S.P, “Railway Engineering”, 6th Edition, Dhanapat Rai Publications, 2004.

2. Khanna S K, Arora M G and Jain S S, Airport Planning and Design, Nemchand and Brothers, Roorkee, (6th Edition)1999.

4. Oza.H.P. and Oza.G.H., “A course in Docks & Harbour Engineering”. Anand Chartor Publishing House Pvt ltd, Gujarat, 2010.

References

2. Rangwala S.C & K.S. “Railway Engineering”, 14th Edition, Charotar Publications, 2005.

2. Rangwala, Airport Engineering, Charotar Publishing House, 1996.

3. S P Bindra, A Course in Docks and Harbour Engineering, Dhanpat Rai and Sons, New Delhi, 1993.

4. J.S. Mundrey, “A course in Railway Track Engineering”. Tata McGraw Hill, 2000.

5. Agarwal M.M., Railway Engineering, Prabha & Co, New Delhi, 2012.

6. Rao G.V., Airport Engineering, Tata Mc Graw Hill, New Delhi, 1992.

7. Seetharaman, “Dock & Harbour Engineering”, 1st Edition, Umesh Publications, 2008.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.0	**Railway Planning and Design**	
1.1	Role of Indian Railways in National Development – Railways for Urban Transportation – LRT & MRTS	1
1.2	Engineering Surveys for Track Alignment – Obligatory points - Conventional and Modern methods (Remote Sensing, GIS & GPS, EDM and other equipments)	2
1.3	Permanent Way, its Components and their Functions: Rails – Types of Rails	1
1.4	Rail Fastenings, Concept of Gauges, Coning of Wheels, Creeps and kinks, Sleepers – Functions, Materials, Density, Materials, Ballastless tracks	2
	Geometric Design of Railway Tracks	
1.5	Gradients and Grade Compensation, Super-Elevation,	2
1.6	Widening of Gauges in Curves, Transition Curves, Horizontal and Vertical Curves.	2
2.0	**Railway Track Construction, Maintenance and Operation**	
2.1	Points and Crossings - Design of Turnouts, Working Principle	2
2.2	Signalling, Interlocking and Track Circuiting	1
2.3	Construction & Maintenance – Conventional, Modern methods and Materials, Track Drainage - Track Modernisation – Automated maintenance and upgrading, Re-laying of Track	2
2.4	Lay outs of Railway Stations and Yards, Rolling Stock, Tractive Power, Track Resistance, Level Crossings.	1
3.0	**Airport Planning and Design**	
3.1	Role of Air Transport, Components of Airports	2
3.2	Airport Planning – Air traffic potential, Site Selection, Zoning	
3.3	Runway Design- Orientation, Cross wind Component, Wind rose Diagram	2
3.4	Geometric Design and Corrections for Gradients	
3.5	Taxiway Design – Geometric Design Elements, Minimum Separation Distances, Design Speed,	2
3.6	Airport Drainage - Airport Zoning - Clear Zone, Approach Zone, Buffer Zone, Turning Zone, Clearance over Highways and Railways	2
4.0	**Airport Layouts, Visual Aids, and Air Traffic Control**	
4.1	Airport Layouts – Apron, Terminal Building, Hangars, Motor Vehicle Parking Area and Circulation Pattern,	1
4.2	Airport Buildings – Primary functions, Planning Concept, Principles of Passenger Flow, Passenger Facilities	1
4.3	Visual Aids – Runway and Taxiway Markings, Wind Direction Indicators, Runway and Taxiway Lightings	

4.4	Air Traffic Control – Basic Actions, Air Traffic Control Network	1
4.5	Helipads, Hangars, Service Equipments.	
5.0	**Docks and Harbour**	
5.1	Definition of Terms - Harbours, Ports, Docks, Tides and Waves, Littoral Drift, Sounding, Area, Depth	2
5.2	Satellite Ports - Requirements and Classification of Harbours – Site Selection	2
5.3	Selection Investigation – Speed of water, Dredging, Range of Tides, Waves and Tidal Currents, Littoral Transport with Erosion and Deposition	
5.4	Shore Considerations- Proximity to Towns/Cities, Utilities, Construction Materials,	2
5.5	Dry and Wet Docks, Planning and Layouts - Entrance, Position of Light Houses,	
5.6	Navigating - Mooring Accessories, Navigational Aids – Coastal Structures- Breakwaters, Wharves.	2
	TOTAL	**36**

Course Designers:

Dr. R. Velkennedy rvkciv@tce.edu
Ms. D. Srividya dsciv@tce.edu

		Category	L	T	P	Credit
14CE630	**FOUNDATION ENGINEERING**	PC	2	2	0	3

Preamble

This course deals with the subsurface exploration and sampling techniques for assessing the soil condition at the construction site. This helps to design an appropriate and economical foundation for the structure. This course offers the theories and methods of determining the bearing capacity of shallow foundations, load carrying capacity of pile foundations, settlement of foundations, earth pressure acting on retaining walls and methods of constructing foundations. Students are also introduced to the concept of stability analysis of retaining walls.

Prerequisite

Fundamentals of Mathematics and Soil Mechanics (14CE530) , knowledge of geology and earth science.

Course Outcomes

	On the successful completion of the course, students will be able to:		Expected Attainment Level (%)	Expected Proficiency Level(grade)
CO33.	Enumerate methods of subsurfaceexploration and site investigation	Apply	70	A
CO34.	Compute the load carrying capacity of foundations	Apply	70	A
CO35.	Suggest and design appropriate shallow foundation	Apply	70	A
CO4.	Determine the load carrying capacity of pile foundations and pile groups.	Apply	70	A
CO5.	Enumerate the various Ground Improvement Techniques	Understand	70	A
CO6.	Calculate the lateral earth pressure also check the stability of retaining walls.	Apply	70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1.	M	M	M	L	-	-	-	-	-	-	-	L	L	M
CO2.	M	M	M	L	-	-	-	-	-	-	-	-	M	M
CO3.	M	M	M	L	-	-	-	L	-	-	-	-	M	M
CO4.	M	L	M	L	-	-	-	L	-	-	-	L	M	M
CO5.	-	-	M	-	-	-	L	-	-	-	-	M	-	M
CO6.	M	M	M	L	-	-	-	-	-	-	-	M	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	10	10	10
Understand	20	10	10	10
Apply	60	80	80	80
Analyse	---	---	---	---
Evaluate	---	---	---	---
Create	---	---	---	---

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is Reconnaissance in Site Investigation?
2. Explain wash boring method of advancing exploratory boreholes.
3. Subsoil at a construction site comprises of coheshionless soil deposit extending for a large depth. Suggest an appropriate in-situ penetration test for subsurface exploration and explain its procedure. How the test results are correlated to various soil properties?

Course Outcome 2 (CO2):

1. Explain Downward Drag Phenomena.
2. Determine the safe load that can be carried by a rectangular footing of 3m x 2m size, placed at a depth of 1.8m below the G.L. The foundation soil has the following properties:
   γ = 17 kN/m^3,c = 13 kN/m^2 and Ø = 20^0. Assume a factor of safety of 2.5 and take Nc' = 11.8, Nq' = 3.8 and Nγ' = 1.3. Use IS code procedure.

3. Estimate the Immediate Settlement of a rigid concrete footing, 1m x 2m size, founded at a depth of 1m in a soil with E = 10^{4}kN/m^2, μ = 0.35. The footing is subjected to a pressure of 230 kN/m^2. Assume Influence coefficient as 1.2.

Course Outcome 3 (CO3):

1. Define efficiency of a Pile Group.
2. A pile of 0.3m diameter is driven through a clayey stratum upto a depth of 10m. It is observed that the undrained cohesion varies from 12 kN/m^2 at its surface to 65 kN/m^2 at a depth of 10 m. Determine the safe load on the pile with a factor of safety of 3.0
3. A 16-pile group has to be arranged in the form of square in soft clay with uniform spacing. Neglecting end bearing, determine the optimum value of the spacing of the piles in terms of the pile diameter, assuming shear mobilization factor of 0.5.

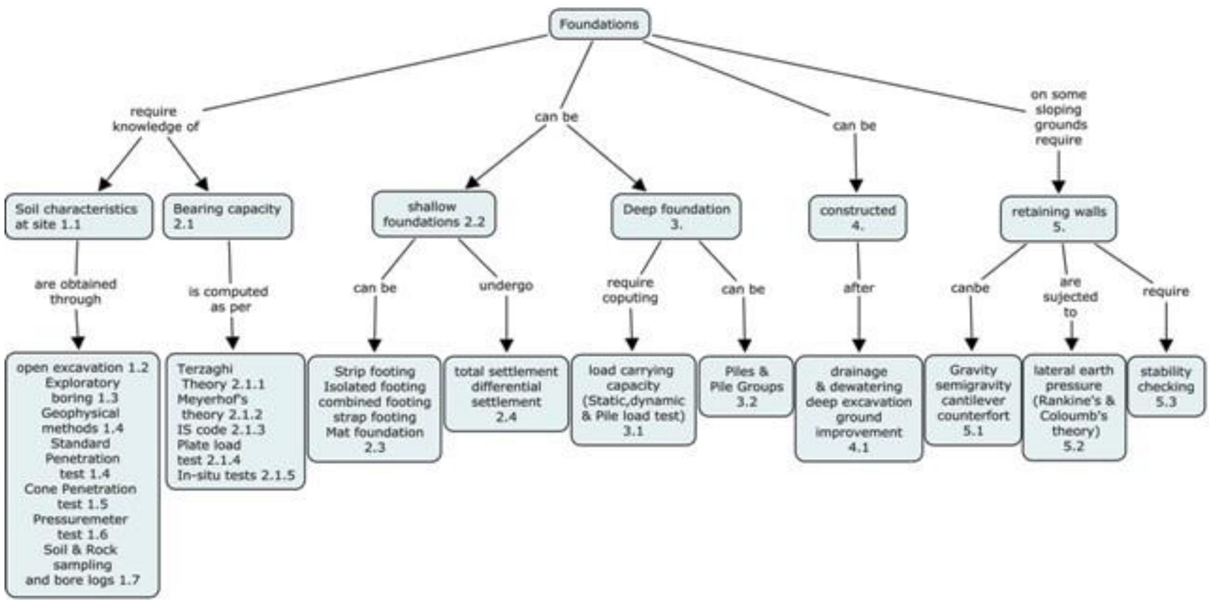
Course Outcome 4 (CO4):

1. Recite the need for dewatering.
2. Mention the different ground improvement techniques along with their suitability.

Course Outcome 5 (CO5):

1. Mention the assumptions in Rankine's theory for Lateral Earth Pressure.
2. Differentiate Active and Passive earth pressures.
3. A masonry retaining wall is 1.0 m wide at top, 2.5 m wide at base and 4 m high. It is trapezoidal in section and has a vertical face on the earth side. The backfill is inclined at an angle of 15^0 with the horizontal. The angle of internal friction of the fill = 30^0 and the unit weight of the fill is 16 kN/m^3. The unit weight of the masonry is 23 kN/m^3. Take angle of friction = 25^0 and the allowable bearing capacity of the soil as 400 kN/m^2. Check the stability of the retaining wall.

Concept Map



Syllabus

Subsurface Exploration and Site investigation: Objectives of Site Investigation - Stages and planning – Methods of Site Investigation - Depth of subsurface exploration and Spacing of bore holes - Geophysical methods – Electrical resistivity Method – Seismic refraction method – Standard penetration test – Static Cone Penetration test – Pressure meter test - Soil sampling techniques - sample disturbance - Methods of obtaining undisturbed samples – Rock sampling – RQD – Core Recovery ratio - Use of Bore log**Shallow Foundations:** Functions and requisites of foundation - Different types of shallow foundations - Bearing Capacities of soils - Factors affecting bearing capacity - Terzaghi's& Meyerhof's bearing capacity theories – Bearing capacity failure for shallow foundations - Bearing capacity of Foundations as per IS Code - Conventional procedure for proportioning of footings for equal settlement - Floating foundation – Plate load test and its limitations - Types of settlement - Total and differential settlement in sand and clays - Codal provisions – Calculation of Bearing capacity and settlement of Foundations based on insitutest results - Contact Pressure - Methods of constructing shallow foundations**Deep Foundations:** Consideration leading to selection of pile foundation - functions and types of pile foundation – Bearing capacity failure in piles - Estimating load carrying capacity of piles by Static approach – Dynamic Formulae – Pile Load Test – Negative skin friction in piles – Use of under-reamed piles in expansive soils - Pile Group – Efficiency of Pile Group – Settlement of piles and pile groups - Methods of constructingPile foundations – Deep excavation**Ground Improvement Techniques:** Drainage and dewatering techniques – Introduction to different ground improvement techniques and their suitability **Lateral earth Pressure and Retaining Walls:** Earth pressure At-rest – Rankine's Theory for Active and Passive earth pressures for cohesive and non cohesive soils - Coulomb's earth pressure theory - Determination of earth pressures by analytical methods - Different types of retaining walls - Design principles of Gravity and Cantilever retaining walls.

Reference Books:

3. Dr. Arora. K.R, "Soil Mechanics and Foundation Engineering (Geotechnical Engineering)", Standard Publishers Distributors, NaiSarak, Delhi, 2011.

1. Braja M. Das, "Principles of Foundation Engineering", Eighth Edition, Thomson (India edition), 2015.

4. Murthy. V.N.S, "Advanced Foundation Engineering", CBS Publishers & Distributors, Darya Ganj, New Delhi, 2007.
5. Joseph E. Bowles, "Foundation Analysis and Design", McGraw Hill, New York, 1982.
6. Varghese P.C, "Foundation Engineering", Prentice Hall of India (P) Ltd., New Delhi, 2005.
7. Donald P. Coduto, "Foundation Design – Principles and Practices", Prentice Hall, New Jersey, 2001.

IS Code of practice :

- IS: 1080(1985) – Design and construction of Shallow Foundations in soils.
- IS: 1888(1982) – Method of load test on soils.
- IS: 1892(1979) – Code of practice for Subsurface investigation for foundations.
- IS: 1904(1986) – Design and construction of Foundations in soils, General requirements.
- IS: 2131(1981) – Method for Standard Penetration test for soils.
- IS: 6403(1981) – Code of practice for determination of Bearing capacity of Shallow Foundations.
- IS: 2911 Part 1 Sec. 1(1979) – Design and construction of pile foundations -Drive cast in-situ concrete piles.
- IS: 2911 Part 1 Sec. 3(1979) – Design and construction of pile foundations -Drive precast piles.
- IS: 2911 Part 3 (1980) - Code of practice for Design and construction of pile foundations – Under-Reamed piles.
- IS: 2911 Part 4 (1985) - Load Test on Piles.
- IS: 8009 Part 1 (1976) - Code of practice for Calculation of Settlements of Foundations – Shallow Foundations subjected to symmetrical static vertical loads.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.	**Subsurface Exploration and Site investigation**	
1.1	Objectives of Site Investigation - Stages and planning	1
1.2	Methods of Site Investigation – Open excavation methods – Exploratory Borings - Depth of subsurface exploration and Spacing of bore holes	1

	Tutorial	2
1.3	Geophysical methods – Electrical resistivity Method – Seismic refraction method	1
1.4	Standard penetration test - Static Cone penetration test – Pressure meter test	2
	Tutorial	2
1.5	Soil sampling techniques - sample disturbance – Methods of obtaining undisturbed samples	1
1.6	Rock sampling – RQD – Core Recovery ratio – Use of Bore log	1
	Tutorial	2
2.	**Shallow Foundations and Bearing Capacity of Soils**	
2.1	Functions and requisites of foundation - Different types of shallow foundations	1
2.2	Bearing Capacities of soils - Factors affecting bearing capacity	1
	Tutorial	2
2.3	Terzaghi's& Meyerhof's bearing capacity theories	1
2.4	Bearing capacity failure for shallow foundations - Bearing capacity of Foundations as per IS Code	1
	Tutorial	2
2.5	Conventional procedure for proportioning of footing for equal settlement - Floating foundation – Plate load test and its limitations	1
2.6	Types of settlement - Total and differential settlement in sand and clays - Codal provisions	1
	Tutorial	2
2.7	Calculation of Bearing capacity and settlement of Foundations based on insitu test results - Contact Pressure - Methods of constructing shallow foundations	1
	Tutorial	2
3.	**Deep Foundations**	
3.1	Consideration leading to selection of pile foundation - functions and types of pile foundation - Bearing capacity failure in piles	1
3.2	Estimating load carrying capacity of piles by Static approach	1

	Tutorial	2
3.3	Estimating load carrying capacity of piles by Dynamic Formulae	1
	Tutorial	2
3.4	Pile Load Test – Negative skin friction in piles - Use of under-reamed piles in expansive soils	1
3.5	Pile Group – Efficiency of Pile Group - Settlement of piles and pile groups - Methods of constructing Pile Foundations - Deep excavation	1
	Tutorial	2
4.	**Ground Improvement Techniques**	
4.1	Drainage and dewatering techniques - Introduction to different ground improvement techniques and their suitability.	1
5.	**Lateral earth Pressure and Retaining Walls**	
5.1	Earth pressure At-rest – Rankine's Theory for Active and Passive earth pressures for cohesive and non cohesive soils	1
5.2	Coulomb's earth pressure theory - Determination of earth pressures by analytical methods	1
	Tutorial	2
5.3	Different types of retaining walls - Design principles of Gravity and Cantilever retaining walls.	1
	Tutorial	2
	Total (Hours)	**48**

Course Designers:

4. Mr. R. Sanjay Kumar sanjaykumar@tce.edu
5. Mr. R.Sankaranarayanan rsciv@tce.edu

14CE640	IRRIGATION AND WATER RESOURCES ENGINEERING	Category	L	T	P	Credit
		PC	2	0	0	2

Preamble

This subject deals with study of irrigations practices and methods adopted in our country. Also to know the irrigation water requirement in order to design the structures like dams, weirs and canals.

Course Outcomes

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

	On the successful completion of the course, students will be able to:		Expected attainment level (%)	Expected proficiency level (grade)
CO1	**Describe the importance of National Water Policy.**	**Understand**	80	S
CO2	**Determine the storage capacity of reservoir for a given demand.**	**Apply**	**80**	**S**
CO3	**Explain the different types and methods of irrigation practices.**	**Understand**	**80**	**S**
CO4	**Illustrate the forces acting on gravity dam.**	**Apply**	**80**	**S**
CO5	**Compute the dimensions of the impervious floor of weir**	**Apply**	**80**	**S**
CO6	**Compute the design parameters of canal**	**Apply**	**80**	**S**
CO7	**Discuss the various concepts of irrigation water management and softwares**	**Understand**	**80**	**S**

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO36.	L	-	L	-	-	L	-	L	-	-	-	-	L	L
CO37.	S	M	S	L	-	-	-	-	-	-	-	-	L	-
CO3.	L	-	L	-	-	L	-	-	-	-	-	-	-	-
CO4.	S	S	S	L	-	-	-	-	-	-	-	-	M	-
CO5.	S	S	S	L	-	-	-	-	-	-	-	-	M	-
CO6.	S	S	S	L	-	-	-	-	-	-	-	-	M	-
CO7	L	-	-	-	L	-	-	-	-	-	-	-	L	-

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination**
	1	**2**	**3**	

Remember	20	20	20	20
Understand	40	40	40	40
Apply	40	40	40	40
Analyse	---	---	---	---
Evaluate	---	---	---	---
Create	---	---	---	---

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Describe National water policy; briefly mention its salient features.
2. Present the status of water resources in India and Tamilnadu.
3. Explain the objectives of water resources development projects in detail.
4. Discuss the problems encountered with our neighbouring states with respect to sharing of water.

Course Outcome 2 (CO2):

1. As a Civil Engineer, you are entrusted to select site for a reservoir. Discuss criteria for site selection and survey to be conducted
2. You are entrusted to fix the capacity of a multipurpose reservoir. Explain the procedure to fix the reservoir capacity.
3. Discuss the various storage zones of reservoir with a neat sketch.
4. Write about the sediment control measures in the reservoir.

Course Outcome 3 (CO3)

1. Discuss the advantages and disadvantages of irrigation
2. Compare sprinkler irrigation and drip irrigation methods and illustrate the conditions of adopting such methods in the field.
3. Classify the irrigation water quality and also explain the irrigation efficiencies in detail.
4. Explain the different methods of irrigation in India with suitable sketches.

Course Outcome 4 (CO4)

1. Explain the step by step approach of design of gravity dam by analytical and graphical method.
2. Draw the elementary profile of a gravity dam and obtain the base width of dam for the safety against tension and sliding.
3. List the forces acting on gravity dam and explain the forces to be considered in extreme load combination of design with sketches.
4. Describe the modes of failure of a gravity dam its remedial measure

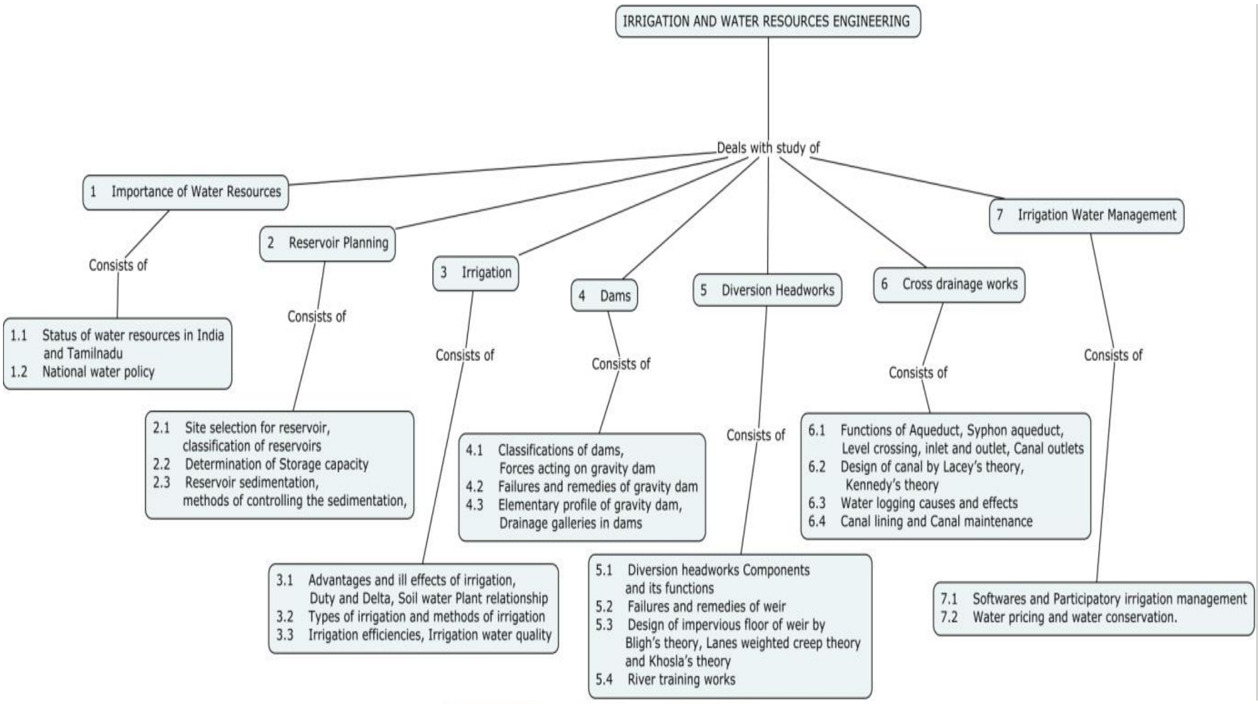
Course Outcome 5 (CO5)

1. Discuss the failures of weir founded on pervious soil and state the remedial measures.
2. Draw the layout of diversion head works and briefly mention their uses.
3. Draw and discuss the silt control devices used in river bed as well as in canal bed.
4. Design an irrigation channel for a discharge of 30 cumecs, Lacey's silt factor = 1.0, side slope = 1/2:1. Determine the longitudinal slope also.

Course Outcome 6 (CO6)

1. Define participatory irrigation management.
2. Write the need and necessity for irrigation management transfer.
3. Describe the various softwares in irrigation water resources management.
4. What is the concept of water pricing with respect to irrigation?

Concept Map



Syllabus

Importance of Water Resources: Status of water resources in India and Tamilnadu- National water policy. **Reservoir Planning:** Site selection for reservoir, classification of reservoirs-Multi-purpose reservoir-Determination of Storage capacity-Reservoir sedimentation, methods of controlling the sedimentation-. **Irrigation:** Advantages and ill effects of irrigation, Duty and Delta, Soil water Plant relationship- Types and methods of irrigation-Tank irrigation-Irrigation efficiencies, Irrigation water quality. **Dams:** Classifications of dams, Forces acting on gravity dam- Failures and remedies of gravity dam- Elementary profile of gravity dam. **Diversion Headwork:** Components and its functions- Failures and remedies of weir- Design of impervious floor of weir by Bligh's theory, Lanes weighted creep theory and Khosla's theory-River training works. **Cross drainage works:** Canal outlets- Design of canal by Lacey's theory, Kennedy's theory- Water logging causes and effects- Canal lining and Canal maintenance. **Irrigation water Management:** Software's-Participatory irrigation management-water pricing-water conservation.

Text Books:

1. Santhosh Kumar Garg, "Irrigation Engineering and Hydraulic Structures" Khanna Publishres-New Delhi. 2012
2. Punmia, B.C and Pande B.B Lal, "Irrigation and Water Power Engineering", Lakshmi Publications (P) Ltd, New Delhi. 2016

Reference Books:

1. Sharma R.K and Sharma T.K' "Irrigation Engineering (Including Hydrology)", S.Chand & Co Ltd, New Delhi. 2009
2. Dilip Kumar Mujumdar, "Irrigation Water Management-Principles & Practice", Prantice Hall of India (P) Ltd, New Delhi. 2014
3. P.N.Modi, "Irrigation Water Resources and Water Power Engineering" Standard Book House, New Delhi, 2014
4. National water Policy 2012, MOWR,GOI

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Importance of Water Resources**	
1.1	Status of water resources in India and Tamilnadu	1
1.2	National water policy	1
2	**Reservoir Planning**	
2.1	Site selection for reservoir, classification of reservoirs	1
2.2	Determination of Storage capacity	1
2.3	Reservoir sedimentation, methods of controlling the sedimentation,	1
3	**Irrigation**	
3.1	Advantages and ill effects of irrigation, Duty and Delta, Soil water Plant relationship	1
3.2	Types of irrigation and methods of irrigation	1
3.3	Irrigation efficiencies, Irrigation water quality	1
4	**Dams**	
4.1	Classifications of dams, Forces acting on gravity dam	2
4.2	Failures and remedies of gravity dam	1
4.3	Elementary profile of gravity dam, Drainage galleries in dams	1
5	**Diversion Headworks**	
5.1	Diversion headworks Components and its functions	1
5.2	Failures and remedies of weir	1
5.3	Design of impervious floor of weir by Bligh's theory, Lanes weighted creep theory and Khosla's theory	2
5.4	River training works	1
6	**Cross drainage works**	
6.1	Functions of Aqueduct, Syphon aqueduct, Level crossing, inlet and outlet, Canal outlets	1

Module No.	Topic	No. of Lectures
6.2	Design of canal by Lacey's theory, Kennedy's theory	2
6.3	Water logging causes and effects	1
6.4	Canal lining and Canal maintenance	1
7	**Irrigation Water Management**	
7.1	Softwares and Participatory irrigation management	1
7.2	Water pricing and water conservation.	1
	Total Hours	**24**

Course Designers:

1. **Dr. S. Chandran** schandran@tce.edu
2. **Dr. T. Baskaran** tbciv@tce.edu
3. **Mr. M.Ramasamy** mrciv@tce.edu

14CE670	DESIGN OF STEEL STRUCTURES	Category	L	T	P	Credit
		PC	2	2	0	3

Preamble

This course offers the design of steel structures as per limit state method. This course follows the recommendation of IS: 800 – 2007. It aims at determination of safe as well as economical steel section for various industrial and framed structures.

Prerequisite

Knowledge of Strength of Materials 14CE220, Mechanics of Solids 14CE321 and Structural Analysis 14CE420

Course Outcomes

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

	On the successful completion of the course, students will be able to		Expected Attainment level (%)	Expected Proficiency level (grade)
CO1	Summarize the codal provisions for design of plate girders,Beam columns and truss.	Create	80	S
CO2	Design a Plate girder using the IS800-2007 Provisions.	Apply	80	S
CO3	Determine the maximum load effects and fatigue effects on a gantry girder and also design the cross – section.	Apply	80	S
CO4	Determine the capacity of column subjected to combined axial compression and moment.	Apply	80	S
CO5	Design a roof truss using rolled steel sections	Create	80	S
CO6	Design a light loaded roof truss using tubular sections.	Create	80	S

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO38.	S	M	M	L	L	M	L	S	M	L	L	-	S	-
CO39.	M	L	M	-	L	M	L	S	M	L	L	-	S	-
CO3	M	L	M	-	L	M	L	S	M	L	L	-	S	-
CO4	M	M	M	L	L	M	L	S	M	L	M	L	S	-
CO5	M	M	M	-	L	M	L	S	M	L	L	L	S	-

CO66	M	M	M	-	L	M	L	S	M	L	L	L	S	-

S- Strong; M-Medium; L-Low

Assessment Pattern: Theory cum Practice Part:

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	10	10	10	10
Apply	40	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	40	40	40	40

Course Level Assessment Questions (Theory Part)

Course Outcome 1 (CO1):

1. What is the difference between plate girder and beam?
2. Determine the buckling resistance moment for a welded plate girder consisting of 500 x 25 mm flange plates and a 1250 x 12 mm web plate in grade 410 steel. Assume a laterally unbraced span of 5.5 m.
3. Design a welded plate girder for a simply supported bridge deck beam with clear span of 20 m subjected to the following:
   i. Dead load including self weight = 20 KN/m
   ii. Imposed load = 10 KN/m
   iii. Two moving loads = 150 KN each spaced 2 m apart

   Assume that the top compression flange of the plate girder is restrained laterally and prevented from rotating. Use mild steel with fy=250 MPa. Design as an unstiffened plate girder with thick webs and also redesign same with intermediate stiffeners utilizing tension field action.

Course Outcome 2 (CO2):

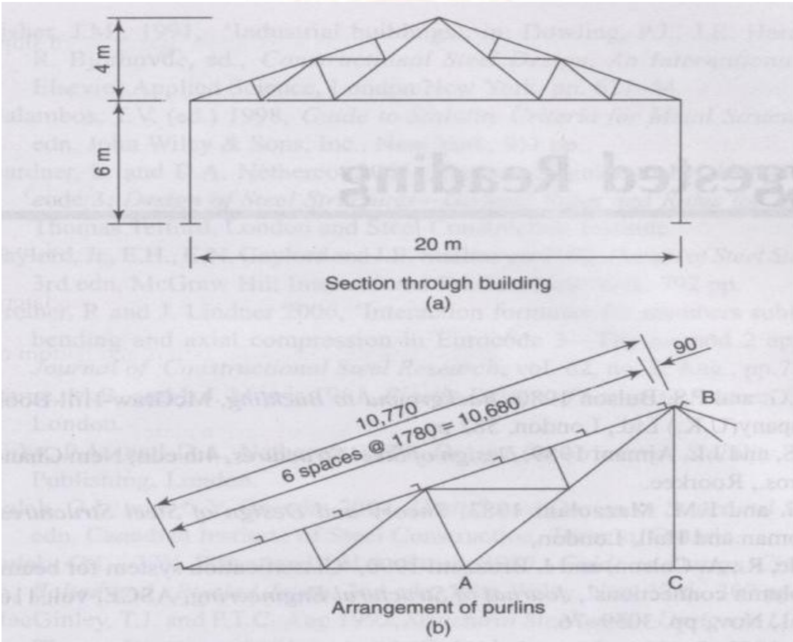
1. Design a gantry girder without lateral restraint along its span, to be used in an Industrial building carrying over head travelling crane for the following data:
   i. Centre to centre distance between columns = 6 m (span of the gantry girder)
   ii. Crane capacity = 50 KN
   iii. Self weight of the crane girder excluding trolley = 40 KN
   iv. Self weight of the trolley, electric motor, hook etc., = 10 KN
   v. Minimum hook approach = 1 m
   vi. Wheel centres = 3 m
   vii. Centre to centre distance between gantry rails = 12 m (span of crane)
   viii. Self weight of rail section = 100N/m
   ix. Yield stress of steel = 250 MPa.
2. Why are simply supported girders preferred to two span gantry girders?
3. List the loads that should be consider while designing a gantry girder.

Course Outcome 3 (CO3):

1. How can load deflection effects be considered in the design of beam columns?
2. A beam column of length 5 m is subjected to a compression of 800 KN and a major axis moment of 4.5 KNM. The weaker plane of the column is strengthened by bracing. If the effective length factor is 0.8, design the beam column, assuming Fe 410 grade steel.
3. A beam column of length 4.5m is subjected to a compression of 850kN and a major axis moment 40kN-m. The weaker plane of the column is strengthened by bracing. If the effective length factor is 0.8, design the beam column, assuming Fe-410 grade steel. Use two channels welded together to form a box section. No need to design for the welding of the two channels.

Course Outcome 4 (CO4):

1. An industrial building is shown in fig. the frames are at 5m centres and the length of the building is 40m. The purlin spacing of the roof is as shown in figure-1. The Building is situated in Delhi. Assume live and wind loads as per IS875 (part 2 and Part 3) and the roof is covered with GI sheeting. Design the roof truss using angle members and gusseted joints. The truss is to be fabricated using welded joints in two parts for transport and assembled at site using bolted joints at A,B and C as shown in figure-1(b).



Section through building
(a)

Arrangement of purlins
(b)

2. List out various elements of the roof truss and mark all its significance.
3. An industrial roof shed of size 20 m* 30 m is proposed to be constructed at Mangalore near a hillock of 160 m and slope is 1 in 2.8. The roof shed is to be built at a height of 120 m from the base of the hill. Determine the design wind pressure on the slope. The height of roof shed shall be 12m.

Course Outcome 5 (CO5):

1. How the tubes are designated?
2. Estimate the capacity of the tubular principal rafter subjected to a compression of 125kN and a tensile force of 80 kN under the reversal effect. The member also subjected to a bending effect of 15kN-m under DL+LL and 9kN-m under DL+WL. Use Yst240 (Yst25) grade, medium class section of 90mm dia. The total length of the principal rafter is 12.25m, which is divided into 6 panels.
   Design a tubular section purlin for the following data:

   Spacing of trusses =4.2m

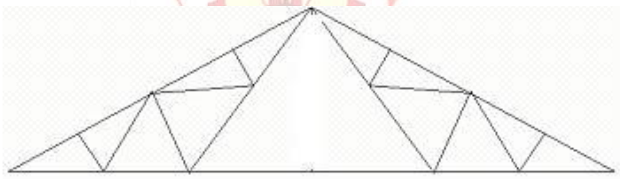
   Spacing of purlin= 2m

   Live load on galvanized iron roofing sheets = 0.6 kN/m2

   Wind load = 1.4 kN/m2

   Slope of main rafter = 31^0

3. Design a tubular fink roof truss of pitch 1/4 for a span of 16m.The configuration of the girder is given in figure.

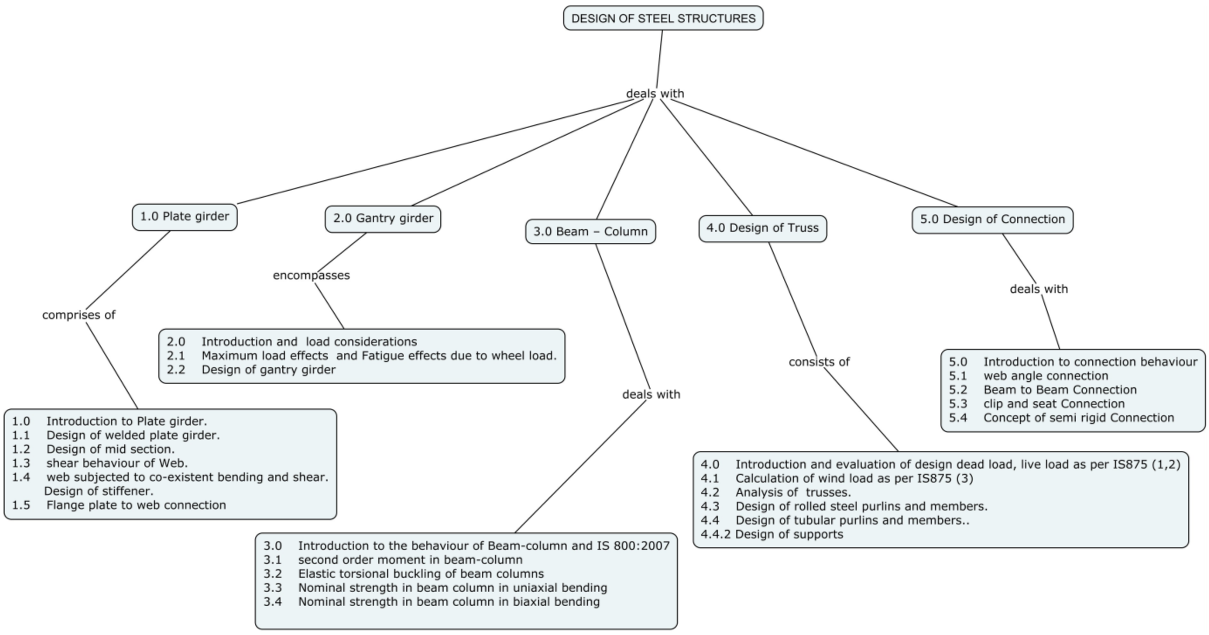


The truss is supported on a RCC column of size 450 x 450 mm of M30 grade concrete. Design the ridge connection. Use Fe 410 grade steel. 80mm nominal bore purlins are placed only on the nodes.

The following are the critical loads.

Members	Critical Forces in kN	
	Compression	Tension
Principal Rafter	60.7	44.2
Tie Member	33.4	54.1
Main Sling & Main Strut	21.3	33.2
Minor sling & Minor Strut	7.8	6.4

Concept Map



Syllabus

Plate girder- Introduction to Plate girder – Difference between beam and plate girder – Design of welded plate girder – Proportioning of web and flange plates – Design of mid section – Curtailment of flange plates – shear behaviour of transversely unstiffened and stiffened web –web subjected to co-existent bending and shear - transverse web stiffener – Bearing stiffener –end bearing stiffener and load bearing stiffener –Longitudinal web stiffener –Flange plate to web connection – Splices - Flange and web **Gantry girder** - Introduction - load considerations - max load effects - Fatigue effects –Determination of maximum bending moment and shear force due vertical component of crane wheel load - horizontal component of crane wheel load - longitudinal effect of wheel load -Design of gantry girder - Connection in gantry girder - **Beam – Column** - Introduction - behaviour of beam-column - second order moment in beam-column – Elastic torsional buckling of beam columns - Nominal strength in beam column in uniaxial bending - Biaxial bending. **Design of Truss** – Introduction - Evaluation of design dead load, live load - wind load. Analysis of trusses. **Design of Truss using Rolled steel sections** – Purlins – truss members – Supports. **Design of Truss using tubular sections** – Purlins – truss members – supports. **Design of Connection -** Introduction – web angle connection – Beam to Beam Connection - clip and seat Connection – Concept of semi rigid Connection.

Text Book

5. Teaching Resource for Structural Steel Design, Vol. 1,2,3 (2000), INSDAG- Institute for Steel Development and Growth, Kolkatta.
6. Subramanian, N., (2008), Design of Steel Structures, oxford university press, USA,.
7. Negi L.S. “Design of steel structures” McGraw Hill Co., New Delhi, 2014
8. Duggal S.K., “Limit state design of steel structures” McGraw Hill Co., New Delhi, 2014

9. www.nptel.ac.in

Indian Standard Codes

1. IS 800-2007 – Code of practice for general Construction in steel
2. SP6 (1) – Hand book for Structural Engineers – Part I :Structural Steel Sections, BIS
3. IS 875 (1-5) - 1987 Code of practice for Design Loads (Other than Earthquake) for Buildings and Structures, BIS
4. IS 816 :1969 - Code of practice for Metal Arc Welding for general Construction in Mild Steel, BIS
5. IS 1161 :1998 – Steel tubes for structural purposes – specifications, BIS.

IS 806 : 1968 – Code of practice for use of steel tubes in general building construction, BIS

Web site

www.steel-insdag.org

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
	Plate girder (according to IS 800 :2007 provision)	
1.0	Introduction to Plate girder – Difference between beam and plate girder & IS 800-2007.	1
1.1	Design of welded plate girder	
1.2	Proportioning of web and flange plates – Design of mid section	1
1.2.1	Curtailment of flange plates	
	Tutorial	2
1.3	shear behaviour of transversely unstiffened and stiffened web	1
1.4	web subjected to co-existent bending and shear	1
1.4.1	transverse web stiffener – Bearing stiffener	
1.4.2	end bearing stiffener and load bearing stiffener –	1
1.4.3	Longitudinal web stiffener	
	Tutorial	2
1.5	Flange plate to web connection	1
1.5.1	Splices - Flange and web	
2	**Gantry girder(according to IS 800 :2007 provision)**	
2.0	Introduction and load considerations	1
2.1	Maximum load effects and Fatigue effects	

2.1.1	Determination of maximum bending moment and shear force due vertical component of crane wheel load	1
2.1.2	Determination of maximum bending moment and shear force due horizontal component of crane wheel load and longitudinal effect of wheel load	1
2.2	Design of gantry girder	1
2.2.1	Connection in gantry girder	
	Tutorial	2
	Beam – Column(according to IS 800 :2007 provision)	
3.0	Introduction to the behaviour of Beam-column and IS 800:2007	1
3.1	second order moment in beam-column	1
3.2	Elastic torsional buckling of beam columns	
3.3	Nominal strength in beam column in uniaxial bending	1
3.4	Nominal strength in beam column in biaxial bending	1
	Tutorial	2
	Design of Truss	
4.0	Introduction and evaluation of design dead load, live load as per IS875 (1,2)	1
4.1	Calculation of wind load as per IS875 (3)	1
4.2	Analysis of trusses	1
	Tutorial	2
	Design of Truss using Rolled steel sections	
4.3	Design of purlins	1
4.3.1	Design of members of Truss using Rolled steel sections	2
	Tutorial	2
4.3.2	Design of supports	1
	Tutorial	2
	Design of Truss using tubular sections	
4.4	Design of tubular purlins	2
4.4.1	Design of members of Truss using Rolled steel sections	1

	Tutorial	2
4.4.2	Design of supports	1
	Tutorial	2
	Design of Connection	
5.0	Introduction to connection behaviour	1
5.1	web angle connection	
5.2	Beam to Beam Connection	
5.3	clip and seat Connection	1
5.4	Concept of semi rigid Connection	
	Tutorial	2
	Total Hours	48

Course Designers:

1. Dr.S.Arulmary samciv@tce.edu
2. Ms. G.Celine Reena celinereena@tce.edu

14CE680	SOIL AND HIGHWAY ENGINNEERING LABORATORY	Category	L	T	P	Credit
		PC	0	0	2	1

Preamble

This laboratory course deals with the determination of various index and engineering properties of soil namely, moisture content, particle size distribution. Atterberg's limits, permeability, shear strength parameters and compaction characteristics. With the knowledge of these properties, students will able to identify, classify and appreciate the use of soil as a suitable construction material and design appropriate foundation for the structure. This course also imparts knowledge on testing of coarse aggregates thus enabling students to identify the coarse aggregates as an appropriate material for pavements.

Prerequisite

14CE530 - Soil Mechanics
14CE540 - Highways and Pavement Engineering

Course Outcomes

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

		Expected Attainment level (%)	Expected Proficiency level (grade)
CO1: Perform tests to determine index properties of soil such as natural moisture content, specific gravity and Atterberg's limits	Apply	95	S
CO2: Perform tests to determine field density, particle size distribution along with compaction characteristics	Apply	95	S
CO3: Perform tests to determine engineering properties of soil such as, permeability and shear strength parameters	Apply	95	S
CO4: Perform tests to determine the Strength parameter for subgrade soil and suggest its suitability for different works	Apply	95	S
CO5: Demonstrate the procedure for determining consolidation parameters of soil, hydrometer analysis and	Understand	95	S
CO6: Demonstrate the procedure for determining Los Angeles abrasion value of aggregates, ductility and viscosity tests on bitumen	Understand	95	S

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO40.	S	S	L	L	---	---	---	---	---	M	---	---	M	L
CO41.	S	S	L	L	---	---	---	---	---	M	---	---	M	L
CO3.	S	S	L	L	---	---	---	---	---	M	---	---	M	L
CO4.	S	S	L	L	---	---	---	---	---	M	---	---	M	L
CO5.	L	---	L	---	---	---	---	---	---	---	---	---	L	---
CO6.	L	---	L	---	---	---	---	---	---	---	---	---	L	---

S- Strong; M-Medium; L-Low

List of Experiments

1. (a) Determination of Specific Gravity of soil using Pycnometer and Density Bottle

   (b) Determination of Water Absorption and Specific Gravity of Aggregates (size > 40 mm).

2. (a) Determination of Moisture Content of soil by Oven Drying method and by using Volumetric Flask.

   (b) Determination of Shrinkage Factors of soil.

3. Determination of Liquid and Plastic Limits of soil.

4. Grain size Distribution Analysis for soil.

5. Determination of Field Density of soil by sand Replacement Method.

6. Determination of Coefficient of Permeability of soil by Constant Head Permeability Test.

7. Determination of Coefficient of Permeability of soil by Variable Head Permeability Test.

8. Determination of Shear Strength parameters of soil by Direct Shear Test.

9. Determination of Unconfined Compressive Strength of clay.

10. Determination of Dry Density - Moisture Content relation using Light Compaction (Standard Proctor Compaction Test).

11. Determination of California Bearing Ratio value of subgrade soil.

12. (a) Determination of Impact Value of aggregates.

(b) Determination of Flakiness and Elongation Indices of aggregates.

Demonstration Experiments:

13. Determination of Consolidation Properties of soil.

14. Determination of Los Angeles Abrasion value of aggregates.

15. Grain Size Distribution - Hydrometer Analysis

16. Determination of Penetration Value and Softening Point of Bitumen

17. Ductility and Viscosity test on bitumen

References

- IS: 2720 - Part-2 (1973), "Determination of water content"
- IS: 2720 - Part-3 Sect.1 -1980, "Determination of Specific gravity - Fine- grained soils".
- IS: 2720 - Part-3 Sect. 2 -1981, "Determination of Specific gravity - Fine, Medium, and coarse - grained soils".
- IS: 2720 - Part 4 -1975, "Grain size analysis".
- IS: 2720 - Part 5-1970, "Determination of Liquid and Plastic Limits".
- IS: 2720 - Part 6 -1972, "Determination of Shrinkage Factors".
- IS: 2720 - Part 7 -1983, "Determination of Water content- Dry density Relation using light compaction".
- IS: 2720 - Part 10 -1973, "Determination of Unconfined Compressive strength".
- IS: 2720 - Part 13 -1972, "Direct Shear Test".
- IS: 2720 - Part 15 -1986, "Determination Consolidation Properties".
- IS: 2720 - Part 28 -1974, "Determination of dry Density of Soil in- place-by the sand-replacement method".
- IS: 2720 - Part 36 -1975, "Laboratory Determination of Permeability of Granular soils (Constant Head)".
- IS:2386 Part 1- 1963, "Methods of Test for Aggregates for Concrete" (Part I -Particle Size And Shape)
- IS:2386 Part 2 -1963, "Methods of Test for Aggregates for Concrete" (Part II Estimation of Deleterious Materials And Organic Impurities)
- IS: 2386 Part 3 -1963, " Methods of Test for Aggregates for Concrete" (Part III-Specific Gravity, Density, Voids, Absorption And Bulking)
- IS:2386 Part 4 -1963, " Methods of Test for Aggregates for Concrete" (Part IV-Mechanical Properties)
- IS 73 (2013) Paving Bitumen

Course Designers:

Dr. R. Velkennedy	rvkciv@tce.edu
Mr. R. Sanjay Kumar	rskciv@tce.edu
Ms. D. Srividya	dsciv@tce.edu

14CE710	ACCOUNTING AND FINANCE

Category	L	T	P	Credit
HSS	3	0	0	3

Preamble

Engineering profession involves lots of decision making. The decisions may range from operation to non-operation. For taking decisions of these kinds, an engineer needs among other data about the organization routine operations and non-routine operations. Accounting is a science which provides all the data by recording, classifying, summarizing and interpreting the various transactions taking place in an organization and thereby helps an engineer in taking vital decisions in an effective manner. Finance is an allied but a separate field relying on accounting and enables engineers in taking useful financial and cost related decisions by providing well defined concepts, tools and techniques.

Course Outcomes

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

CO	Course Outcome	Blooms Taxonomy	Expected Attainment Level	Expected Proficiency Grade
CO1	Explain the basic concepts and process of accounting and finance.	Understand	80	B
CO2	Develop trail balance and financial statements like Trading, Profit and Loss accounts, Balance sheet and Cost sheet	Apply	80	B
CO3	Demonstrate the concepts and operations of budgetary control	Understand	80	B
CO4	Apply techniques like breakeven analysis and Capital budgeting for an organization.	Apply	80	B
CO5	Select the right sources of finance and mobilize the right quantum of finance and make use of them in most profitable investment avenues.	Apply	80	B

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1.	M													
CO2.	S	M	M		M	M		M			S	L	L	L
CO3.	M					M					M		L	L
CO4.	S	M	M		S	M		M		L	S	L	L	L
CO5.	S	M	M			M					S	L	L	

S-Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	50	50
Analyze	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Describe the term Accounting.
2. List the concepts of accounting.
3. Recall the methods of depreciation.
4. Name the factors causing depreciation.
5. Write the classification of cost.
6. Define the term capital budgeting.

Course Outcome 2 (CO2):

1. Prepare trading account from the information given below and calculate the net profit. Gross profit.....Rs.10,000; Office and administrative expenses .....Rs.1000; selling and distribution expenses ....Rs.500; Interest on investment received...Rs.500; commission received....Rs.200
2. Compare Trading and profit and loss account. Compute depreciation for an asset worth Rs.10,000 and having a scrap value of Rs.2,000 and a life time of 4 years under straight line method.
3. Outline the cost classification based on the nature of cost.
4. Apply the net present value method of evaluating investment decision and say whether the following project could be selected for investment.

Year	Cash inflows in Rs.
0	10,000
1	3,000
2	4,000
3	4,000
4	2,000
5	2,000

Course Outcome 3(CO3)

1. Construct journal entries for the following business transactions.
   - X brings in cash Rs.10,000 as capital
   - Purchases land worth Rs.2000
   - He purchases goods worth Rs.5,000

- He sells goods for Rs.10,000
- He incurs travelling expenses of Rs.200.

2. Estimate Gross profit and Net profit and the financial position from the following trial balance extracted from the books of Mr.Kumar as on 31.12.2010.

Debit Balances	**Amount in Rs.**	**Credit Balances**	**Amount in RS.**
Buildings	30,000	Capital	40,000
Machinery	31,400	Purchase returns	2,000
Furniture	2,000	Sales	2,80,000
Motor car	16,000	Sundry creditors	9,600
Purchases	1,88,000	Discounts received	1,000
Sales return	1,000	Provision for bad debts	6,00
Sundry debtors	30,000		
General expenses	1,6000		
Cash at bank	9,400		
Rates and taxes	1,200		
Bad debts	4,00		
Insurance premium	8,00		
Discount allowed	1,400		
Opening stock	20,000		
Total	**3,33,200**	**Total**	**3,33,200**

3. Calculate depreciation for a machinery purchased by senthil for Rs.4,00,000 on 1^{st} April 2010.He also adds an additional machinery for Rs.40,000 on 1^{st} April 2011.Depriciation is to be provided at 10% per annum using straight line method. The firm closes its books on 31^{st} March every year.

4. A factory is currently working at 50% capacity and the product cost is Rs.180 per unit as below:

   Material ....Rs.100; Labour.....Rs.30 Factory overheads....Rs.30 (40% fixed) Administration overhead .Rs.20 (50% fixed)

   The product is sold at Rs.200 per unit and the factory produces 10,000 units at 50% capacity. Estimate profit if the factory works to 60% capacity. At 60% working raw material increases by 20% and selling price falls by 20%.

Course Outcome 4(CO4)

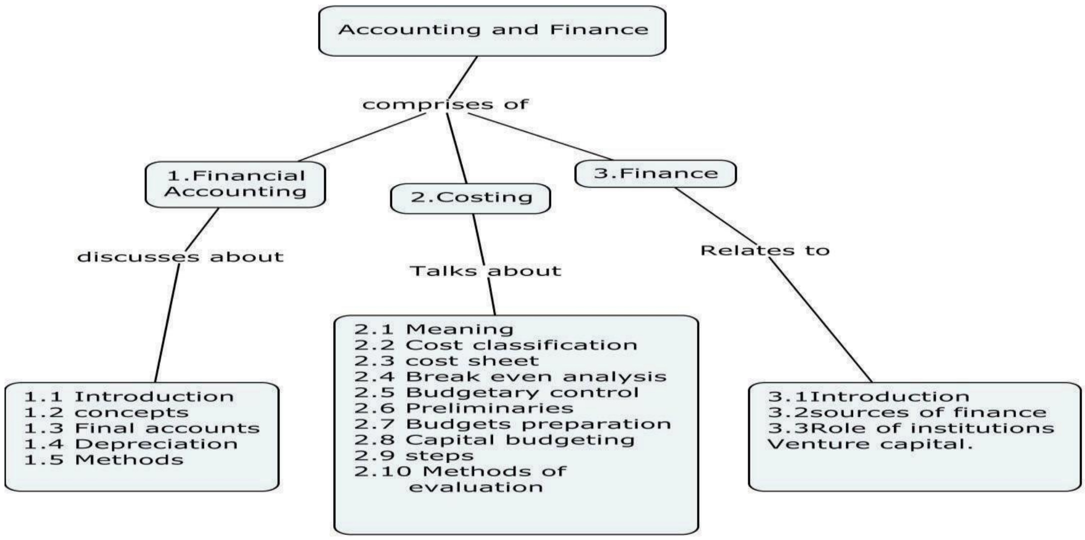
1. From the following information calculate the Breakeven point in terms of units and breakeven point in terms of sales.
   Sales....Rs.10,000; Variable costs Rs.6,000,fixed costs Rs.2000:profit Rs.2,000;No. Of units produced 1,000 units

2. Describe the term ' Breakeven analysis'
3. Calculate the breakeven point and margin of safety from the following information Fixed cost ...Rs.10,000, sales in Rs.25,000,selling price per unit Rs.30; variable cost per unit Rs.10

Course Outcome 5(CO5)

1. Write the meaning of Owner's capital
2. What is dividend?
3. Distinguish commercial bank and cooperative bank.
4. Bring out the various sources of short term, medium term and long term sources of finance

Concept Map



Syllabus

Accounting: Introduction and Definition- Accounting concepts and conventions-Final Accounts-Preparation of Trading, Profit and Loss Account and Balance Sheet. Depreciation - Meaning-Need and objectives-Basic factors-Methods of providing depreciation.

Cost Accounting: Meaning and Importance-Cost-Elements of cost- Cost classification-Preparation of cost sheet. Break even analysis-Managerial applications. Budget and budgetary control. Meaning- Objectives of budgetary control-Preliminaries for operation of budgetary control-Budgets-Types of budgets and their preparation. Capital budgeting- Meaning-Importance-steps in capital budgeting-Information needed-Methods of evaluating capital budgeting decisions.

Finance: Introduction-Definition-objectives-functions of finance-sources of finance-Short- term, Medium term, and Long-term-Role of special financial institutions in financing-Venture capital.

Text Books

1. M.C.Shukla,T.S.Grewal,"AdvancedAccounts-Volume-I,2010 Reprint, S. Chand & company Ltd.,2010.
2. Prasanna Chandra, "Financial Management-Theory and practice" seventh Reprint, Tata McGraw-Hill publishing company Limited,2010.

Reference Books

1. A.Ramachandra Aryasri, V.V Ramana Murthy, "Engineering Economics and Financial Accounting, Tata McGraw Hill, 2010.
2. Dr.V.R.Palanivelu, "Accounting for Management" Third Edition, 2013, University Science Press New Delhi.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	**Financial accounting**	
1.1	Introduction and Definition	1
1.2	Accounting concepts and conventions	2
1.3	Final accounts-Preparation of Trading profit and Loss account and Balance sheet.	4

1.4	Depreciation- Meaning, Need and Objectives	2
1.5	Basic factors-Methods of providing depreciation	3
2.	**Cost Accounting**	

Category L T P Credit

2.1	Meaning and Importance	1
2.2	Cost-Elements of cost-Cost classification	2
2.3	Preparation of cost sheet	2
2.4	Break even analysis-Managerial applications	2
2.5	Budget and budgetary control. Meaning- Objectives of budgetary control	1
2.6	Preliminaries for operation of budgetary control	1
2.7	Types of budgets and their preparation	3
2.8	Capital budgeting-Meaning-Importance	1
2.9	Steps in capital budgeting-Information needed	1
2.10	Methods of evaluating capital budgeting decisions. Payback period-Rate of Return-Net present value-Internal Rate of return method	3
3	**Finance**	
3.1	Introduction-Definition-objectives-functions of finance	2
3.2	sources of finance-Short-term, Medium term, and Long-term	2
3.3	Role of special financial institutions in financing-Venture capital.	3
	Total	**36**

Course Designers:

1	Dr.S.Muralidharan	murali@tce.edu
2	Dr.R.Muruganandham	rmmech@tce.edu

PC 2 2 0 3

14CE720 PROJECT MANAGEMENT

Preamble

This course gives an exposure to the basic concepts involved in the formulation of a project, project management principles, importance and need for network techniques and its applications to a project.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to:		Expected attainment level (%)	Expected proficiency level(grade)
(CO1) Explain project, project management, life cycle and project formulation	Understand	70	A
(CO2) Analyze and Manage time in projects through Gantt charts, And network techniques.	Apply	70	A
(CO3) Analyse and manage time in projects through CPM and PERT, update and monitor projects	Apply	70	A
(CO4) Manage resources of project using resource smoothing and levelling techniques	Analyze	70	A
(CO5) Optimize resources of projects using scheduling, fast tracking and re-estimation techniques	Apply	70	A
(CO6) Identify the need for communication and risk management in projects with emerging trends in project management	Apply	70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO42	L	L	L	L	-	M	L	L	M	M	L	M	L	-
CO43	S	M	M	M	M	-	-	L	M	L	S	M	S	M
CO3	S	M	M	M	M	-	-	L	M	L	S	M	S	M
CO4	S	M	M	M	-	M	L	-	L	M	-	S	S	S
CO5	S	M	M	S	-	M	L	-	L	M	-	S	S	S
CO6	L	L	L	L	L	-	M	-	S	M	M	L	L	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's	Continuous	Terminal

Category	Assessment Tests			Examination
	1	2	3	
Remember	20	10	10	10
Understand	20	30	10	10
Apply	60	60	60	60
Analyze	0	0	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

37. **Define project and project management. Mention its need**
38. **Discuss the functions of project management**
39. **Discuss the life cycle of projects with influencing factors**

Course Outcome 2 (CO2):

40. **Differentiate between CPM and PERT**
41. **A project consists of six activities with the following logical relationships. Draw a network for the project and determine the critical path using traditional method**

- A and B are initial activities and can be performed concurrently
- C follows A but cannot start until B is over
- D and E succeed B
- C and D precede F
- E and F are terminal activities

Activity	A	B	C	D	E	F
Duration (Days)	7	8	3	2	7	4

Find the status of the project on the 10th day of its commencement.

42. **Conduct Event oriented network analysis for the following project and determine:**

- Earliest and latest allowable occurrence times for the events
- Expected time and standard deviations for activities
- Project completion time and its degree of variability
- What is the probability of completing the project 2 days ahead of schedule?
- What is the probability of not completing the project 1 day behind schedule?
- Find the due date that has 75% chance of being met?

Activity (i-j)	1-2	1-3	2-4	3-4	3-5	4-5	5-6
t_0 days	2	3	4	0	7	2	4

t_m days	3	3	10	0	12	7	6
t_p days	5	3	12	0	15	9	8

Course Outcome 3 (CO3)

43. **Write the need for balancing of resources in project? Mention its significance**
44. **For an automobile industry project you as a project manager is vested with the responsibility of balancing manpower requirement, which method would you adopt for this process. Justify your answer with suitable reasons.**
45. **Balance the resource demand for the following project so as to meet the availability of only 7 men/day**

Activity (i-j)	0-1	0-3	0-6	1-2	3-4	3-7	6-7	2-5	4-5	7-8	5-8
Duration (days)	2	2	1	4	5	8	3	1	4	5	3
Manpower	3	6	4	2	2	4	5	4	2	2	5

Course Outcome 4 (CO4)

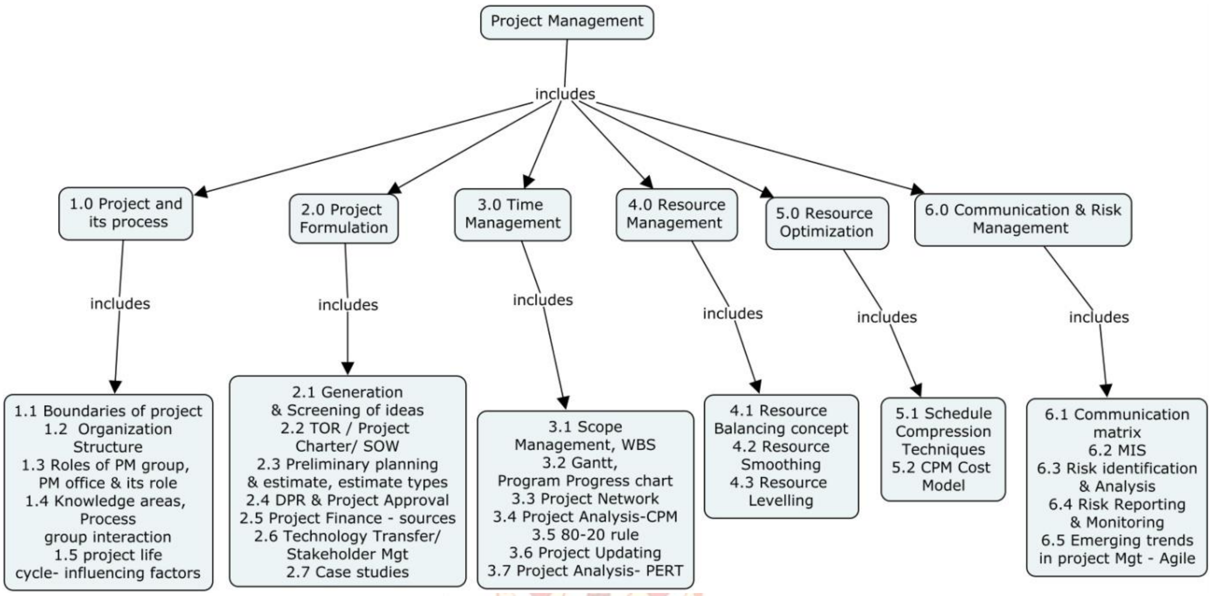
1. Define the term direct cost in projects with examples
2. Write the need and meaning of fast tracking and estimation of projects
3. A project consists of 7 activities with costs and times gives as shown in table. Crash the project and determine the optimum time and minimum cost relationship for the project. Assume the indirect cost to vary at Rs.500/- per day.

Activity (i-j)	1-2	1-3	2-4	3-4	3-5	4-5	5-6
Normal time days	5	7	4	2	5	3	4
Crash time days	3	4	2	1	3	2	1
Normal cost Rs.	500	100	200	400	350	380	50
Crash cost Rs.	800	300	500	750	800	900	150

Course Outcome 5(CO5)

1. List the benefits and limitations of latest tools in project management
2. **Discuss why effective communication is needed for the success of any projects taking an example**
3. **Take of project of your choice in a mechanical industry and list and discuss the risks in the project along with possible methods of its mitigation.**

Concept Map



Syllabus

Project and its process- Define project and process, boundaries of project, Objectives and functions of Project management, characteristics and types of projects, organization structure / styles, roles of project management group, project management office and its role, project knowledge area, project integration- process group interaction. Project flow, project life cycle- influencing factors. - Case study. **Project Formulation:** Generation and Screening of PM ideas- Triple Constraint – Time, Cost and Scope. TOR/ Project Charter/ SOW (Statement of Work)- Creation of project Charter. Preliminary planning and estimate- Types of estimate- Ball park, Parametric and Bottom up estimates. Project Presentation & Approval – Detailed Project Report & Approval (Technical and Budget Sanction), Project finance- sources of finance. Technology transfer- PPP Concepts,BOT, BOLT, BOOT. Stakeholder Management - Case study. **Time Management:** Project Scope Management - Work break down structure- Activity/ Task- Events- Case study. Project planning tools- Rolling wave planning. Gantt Charts, Milestone chart, Program Progress chart- Creating milestone plan. Project Network- Fulkerson's rules – Activity-On-Arrow and Activity- On -Node networks. Analyze project time- Critical path method (deterministic approach- activity oriented network analysis- 80-20 rule- Case study, type of time estimates & Square network diagram. Project updating and monitoring- Case study. Estimate time- Program Evaluation & Review Technique (Probabilistic Approach)- Event oriented network analysis- Optimistic, Pessimistic and Most likely time, Degree of variability in average time, Probabilistic estimate, % utilization of resources. **Resource Management:** Types of resource- Time, Men, Material, Machinery, Money, Space. Balancing of resource- Resource Smoothing technique- Time constraint. Resource levelling technique- Resource constraint- Case study. **Resource optimization:** Types of cost – Direct, Indirect and Total Cost. Variation of Cost with time. Schedule Compression Techniques- Crashing, Fast Tracking & Re-estimation- Crash time and crash cost. Optimize project cost for time and resource.CPM Cost model. **Communication Management:** Communication Management- meaning and process, communication matrix, Management information system, Guidelines of meeting- Case study. **Risk Management:** Risk management – meaning and process, Risk identification and analysis techniques- FMEA and SWOT analysis- Risk reporting and monitoring- Case study. **Emerging trends in project Management:** Introduction to Theory of Constraints, Agile Project management - Case study. Stakeholder Management – brief idea.

Text Book

1. Punmia B. C. and Khandelwal K.K., "Project Planning and Control with PERT/CPM", Laxmi publications, New Delhi, 1989.
2. "A Guide to the Project Management Body of Knowledge (PMBOK Guide) - Fifth Edition, An American National Standard, ANSI/PMI 990001-2008"

References

1. Jerome D. Wiest and Ferdinand K. Levy, "A Management Guide to PERT/CPM", Prentice Hall of India Publishers Ltd., New Delhi, 1994.
2. Srinath L.S., "PERT & CPM- Principles and Applications", Affiliated East West Press Pvt., Ltd., New Delhi, 2008
3. A Risk Management Standard, AIRMIC Publishers, ALARM, IRM: 2002
4. Gene Dixon, "Service Learning and Integrated Collaborative Project Management", Project Management Journal, DOI:10.1002/pmi, February 2011, pp.42-58
5. NPTEL videos at nptel.ac.in/courses/112102106 by Prof. Arun Kanda, Dept of Mechanical Engineering, IIT, Delhi

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.0	**Project and its process**	
1.1	Define project and process, boundaries of project	1
1.2	Objectives and functions of Project management, characteristics of projects, Organization structure / styles of project	1
1.3	Roles of project management group, project management office and its role	1
1.4	Project knowledge area, project integration- process group interaction	1
1.5	Project flow, project life cycle- influencing factors, Case study	1
2.0	**Project Formulation**	
2.1	Generation and Screening of PM ideas, Triple Constraint – Time, Cost and Scope	1
2.2	TOR/ Project Charter/ SOW (Statement of Work)- Creation of project Charter	2
2.3	Preliminary planning and estimate- Types of estimate- Ball park, Parametric and Bottom up estimates	1

2.4	Project Presentation and Approval- Detailed Project Report and Approval (Technical and Budget Sanction)	1
2.5	Project Finance - sources	1
2.6	Technology Transfer – PPP (BOT,BOLT, BOOT), Stakeholder Management	2
2.7	Case study - Tutorial	2
3.0	**Time Management**	
3.1	Project Scope Management, Work break down structure -Activity/ Task- Events- Case study. Project planning tools- Rolling wave planning	2
3.2	Gantt Charts, Milestone chart, Program Progress chart- Creating milestone plan	2
3.3	Project Network- Fulkerson's rules – A-O-A and A-O-N networks Introduction to project management software	2
3.4	Analyze project time- Critical path method (deterministic approach- activity oriented network analysis- Square network diagram	2
3.5	80-20 rule, type of time estimates - Case study	1
3.6	Project updating and monitoring- Case study	1
3.7	Estimate time- Program Evaluation & Review Technique (Probabilistic Approach)- Event oriented network analysis- Optimistic, Pessimistic and Most likely time, Degree of variability in average time, Probabilistic estimate, % utilization of resources.	2
	Tutorial	2
4.0	**Resource Management**	
4.1	Types of resource- Time, Men, Material, Machinery, Money, Space. Balancing of resource- need and purpose- Case study	1
4.2	Resource Smoothing technique- Time constraint	2
4.3	Resource levelling technique- Resource constraint	2
	Tutorial	2
5.0	**Resource optimization**	
5.1	Types of cost – Direct, Indirect and Total Cost. Variation of Cost with time. Schedule Compression Techniques- Crashing, Fast Tracking & Re-estimation Crash time and crash cost	2
5.2	Optimize project cost for time and resource- CPM Cost model- Case study	2

	Tutorials	2
6.0	**Communication & Risk Management**	
6.1	Communication Management- meaning and process, communication matrix	1
6.2	Management information system, Guidelines of meeting- Case study	1
6.3	Risk management – meaning and process. Risk identification and analysis techniques- FMEA and SWOT analysis	1
6.4	Risk reporting and monitoring- Case study	1
6.5	Emerging trends in project management: (Brief concept only)- Theory of Constraints, Agile Project Management. Stakeholder management – brief concept	1
	Total Periods	**48**

Course Designers:

1. Dr. G. Chitra gcciv@tce.edu
2. Dr. S. Chandran schandran@tce.edu

14CE770	DESIGN OF REINFORCED CONCRETE STRUCTURES	Category	L	T	P	Credit
		PC	2	2	0	3

Preamble

Design of reinforced concrete structures started in the beginning of last century following purely empirical approach. Thereafter came the so-called rigorous elastic theory where the levels of stresses in concrete and steel are limited so that stress-deformations are taken to be linear. However, the limit state method, though semi-empirical approach, has been found to be the best for the design of reinforced concrete structures. This course offers analysis and design of reinforced concrete structures. The course will focus on explaining the background of current design specifications for reinforced concrete structures. It aims at determination of safe as well as economical sections and their reinforcement under various types of load combinations. At the end of the course, student has a comprehensive design knowledge related to structures and systems that are likely to be encountered in professional practice.

Prerequisites

Knowledge of Mathematics, Strength of Materials14CE220 , Structural Analysis 14CE420 and Design of reinforced concrete elements 14CE610

Course Outcomes

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

	On the successful completion of the course, students will be able to		Expected Attainment level (%)	Expected Proficiency level (grade)
CO1	Analyse and design the slabs based on Yield line theory and other flat and grid floor slab systems and draw the reinforcement details	Apply	80	S
CO2	Analyse and design the building frames by approximate method and draw the reinforcement details	Apply	80	S
CO3	Design the foundation and draw the reinforcement details	Apply	80	S
CO4	Design the staircases and draw the reinforcement details	Apply	80	S
CO5	Design the retaining walls and draw the reinforcement details	Apply	80	S
CO6	Design the water tanks and draw the reinforcement details	Apply	80	S

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO47.	S	M	S	-	-	-	M	M	M	S	-	-	M	-
CO48.	S	M	S	-	-	-	M	M	M	S	-	-	M	-
CO49.	S	M	S	-	-	-	M	M	M	S	-	-	M	-
CO50.	S	M	S	-	-	-	M	M	M	S	-	-	M	-
CO51.	S	M	S	-	-	-	M	M	M	S	-	-	M	-
CO52.	S	M	S	-	-	-	M	M	M	S	-	-	M	-

S- Strong; M-Medium; L-Low

Assessment Pattern:

Assessment	Test – I	Test – II	Test – III	End Semester
Remember	10	10	10	10
Understand	10	10	10	10
Apply	80	80	80	80
Analysis	--	--	--	--
Evaluate	--	--	--	--
Create	--	--	--	--
Total	100	100	100	100

Course Level Assessment Questions

CO1: Analyse and design the slabs based on Yield line theory and other flat and grid floor slab systems and draw the reinforcement details

1. Explain virtual work method.
2. Draw the yield line pattern for a triangular slab supported on adjacent edges and also for a trapezoidal slab with three edges fixed and one edge free.
3. Find the bending moment for simply circular slab subjected to uniformly distributed load using yield line theory.
4. Define the terms: Column and Middle strips.
5. What are the IS codal provisions for finding area and spacing of reinforcement for the flat slab.
6. Make use of yield line theory and analyse a one way continuous slab and determine the collapse load for the square slab by using virtual work method and also equilibrium method.
7. Make use of yield line theory, analyse yield line pattern of a rectangular slab using both virtual work and equilibrium methods and determine that the yield pattern condition has to be satisfied.
8. Make of IS codal provisions, design the flat slab for an office building having the interior panel of size 6.5m x 6.5m. The size of the column is 300mm diameter. Super imposed load is 5 kN/m^2. Floor finishes = 1.5 kN/m^2. Partition walls = 2 kN/m^2. Use M20 & Fe415 as materials. Draw the reinforcement details.
9. Make use of theory of grid floor slab system, analyse and determine the reinforcement required for the slab of area 15m x 21m and the ribs are spaced at 1.5m on both directions and subjected to a live load of 6 kN/m^2, floor finish of 1.5 kN/m^2, partition wall of 2 kN/m^2. Use M20 & Fe415 as materials. Draw the reinforcement details.

CO2: Analyse and design the building frames by approximate method and draw the reinforcement details

1. What are the assumptions made in portal method of analysis of frames?
2. Define the terms: Substitute Frame
3. What are the differences between portal and substitute frame methods of analysis?
4. How to find the axial load on columns in cantilever method?

5. What are the limitations of substitute frame, portal and cantilever methods of analysis of frames?
6. Make use of portal method and analyse a multistory building frame, which has three equal bays of 3.5m each and two floors. The height between floors is 4m. The wind loads acting at roof (top floor) and first floor levels are H1=50kN and H2=25kN respectively. The columns and beams are having the same cross section. Compute the forces and moments in columns and beams.
7. A multistory building frame has two bays and two floors. The height between floors is 5m. The lengths of first and second bays are 4m and 6m respectively. The wind loads acting at roof (top floor) and first floor levels are H1=75kN and H2=50kN respectively. The columns and beams are having the same cross section. Analyse the frame and design any one beam in the frame using cantilever method. Draw the reinforcement details.
8. A multistory building frame has two bays and two floors. The height between floors is 5m. The lengths of first and second bays are 4m and 6m respectively. The wind loads acting at roof (top floor) and first floor levels are H1=75kN and H2=50kN respectively. The columns and beams are having the same cross section. Analyse the frame and design any one beam in the frame using portal method. Draw the reinforcement details.

CO3: Design the foundation and draw the reinforcement details

1. What are the IS codal provisions for the design of longitudinal and lateral reinforcement for a pile?
2. Find the bending moment for the design of pile cap connecting three piles?
3. Explain the design principles of mat foundation.
4. Make of IS codal provisions, design a pile under a column subjected to an axial load of 900 kN. The pile is to be driven to a hard stratum available at a depth of 6.5m. Use M20 grade concrete and Fe415 grade steel reinforcement. Draw the reinforcement details also.
5. Make of IS codal provisions, design a pile cap connecting three piles of size 300mm in diameter used to support a column at the CG of the section subjected to a load of 700 kN. The centre-to-centre distance between the piles is 1.60m. Use M20 and Fe415 as materials. Draw the reinforcement details.

CO4: Design the staircases and draw the reinforcement details

1. Define the terms: rise and tread
2. Explain the different types staircase with neat sketches.
3. Draw the plan and cross section of dog-legged staircase showing reinforcement details.
4. Make use of limit state method, design a dog-legged staircase required for an institutional building having a clear roof height of 3.60m. The thickness of roof is 125mm. The live load on the staircase is 3kN/m^2. Consider other dead loads also. Use M20 and Fe415 as materials. Draw the reinforcement details also.

CO5: Design the retaining walls and draw the reinforcement details

1. Explain the different types of retaining walls with neat ketches.
2. What is the purpose of providing shear key to the retaining wall?
3. What are the difference between counterfort and buttressed walls?
4. Draw the cross section of cantilever retaining wall showing reinforcement details.
5. Make use of limit state method, design the stem of the retaining wall using the following data and also check the stability of the wall against overturning and sliding.

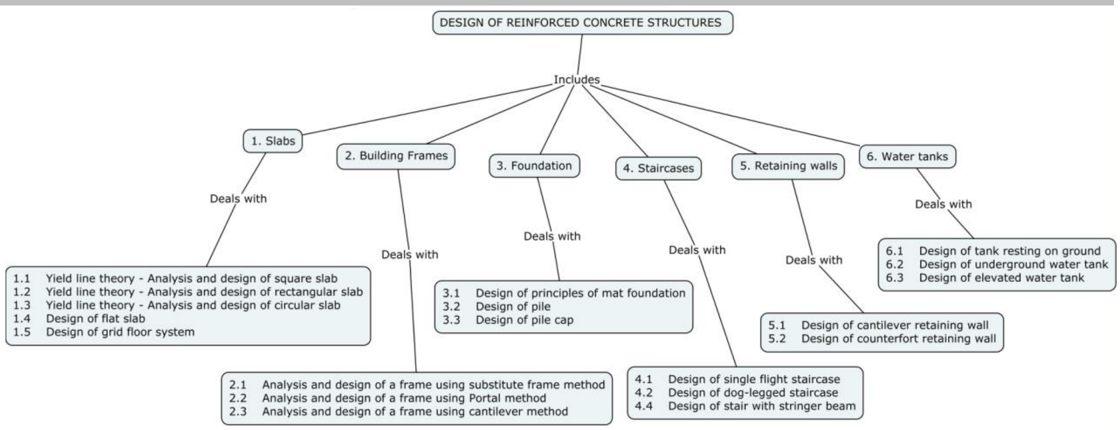
Height of earth to be retained above the GL: 4.5m; Density of earth: 18 kN/m^3; Angle of internal friction: 30^0; SBC of soil: 260 kN/m^2; Coeff. of friction between soil and concrete: 0.5; Surcharge load: 10 kN/m^2; Materials: M20 & Fe415. Draw the reinforcement details.

6. Make use of limit state method, design the base slab of the counterfort retaining wall using the following data and also check the stability of the wall against overturning and sliding. Height of earth to be retained above the GL: 6.0m; Density of earth: 18 kN/m^3; Angle of internal friction: 30^0; SBC of soil: 275 kN/m^2; Coeff. of friction between soil and concrete: 0.5; Surcharge load: 10 kN/m^2; Materials: M20 & Fe415. Draw the reinforcement details.

CO6: Design the water tanks and draw the reinforcement details

1. What are the IS codal provisions for the design of reinforcement in walls and floor of water tank?
2. Define the term: Meridional thrust.
3. Draw the cross section of water tank resting on ground having flexible joint showing reinforcement details.
4. Make use of IS codal provisions, explain the design principles of underground water tank.
5. Design a circular water tank resting on ground with flexible joint at base storing water of capacity of 300000 litres. The depth of water tank including a free board of 200mm is 3.5m. Use M20 and Fe415 as materials. Draw the reinforcement details also.
6. Design the sidewalls and ring beam at the junction of sidewalls & top dome of an elevated circular water tank for a capacity of 250,000 litres. Use M25 and Fe500 grade materials. Draw the reinforcement details also.

Concept Map



Syllabus

Slabs - Yield line theory - Equilibrium and virtual work method - Analysis and design of square, rectangular and circular slabs - flat slab - grid floor system – Reinforcement detailing of slabs. **Building frames** - Substitute frame method - Portal and Cantilever methods of analysis - Design of frame components – Beam and Column – Reinforcement detailing of frames. **Foundation** – Design principles of mat foundation - Design of piles and pile caps – Reinforcement detailing of foundation. **Staircases** – Single flight and dog-legged staircases – Stairs with stringer beams – Reinforcement detailing of staircases**. Retaining walls** – Reinforced concrete walls – Cantilever and counterfort retaining walls – Reinforcement detailing of walls. **Water tanks** - Tank resting on ground and underground water tanks - Elevated circular water tank – Reinforcement detailing of water tanks.

Text Books

1. N. Krishna Raju Advanced Reinforced Concrete Design IS 456-2000, CBS Publishers and Distributors, New Delhi, 2010.
2. P.C. Varghese, Advanced Reinforced Concrete Design, Prentice Hall of India, Pvt. Ltd., New Delhi, 2013.

Reference Books

1. M.L. Gambhir, Design of Reinforced Concrete structures, Prentice Hall of India Private limited, New Delhi, 2012.
2. N. Subramanian, Design of Reinforced Concrete Structures, Oxford University Press, New Delhi, 2014.
3. B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, RCC Designs (Reinforced Concrete Structures), Laxmi Publications Pvt. Ltd., New Delhi, 2015.
4. S.N. Sinha, Reinforced Concrete Design, Tata McGraw-Hill, New Delhi, 2002.
5. I.C.Syal and A.K.Goel, “Reinforced Concrete Structures”, S.Chand and Company Ltd, New Delhi, 2012.
6. Self learning materials – online courses - http://nptel.ac.in/courses/ 105105104/20

IS Codes

1. IS 456:2000 Plain and Reinforced Concrete – Code of Practice.
2. IS 875(1-5): 1987 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures.
3. IS 2911(1): 2010 Design and construction of pile foundations – Code of practice – Concrete piles
4. IS 3370(Part 1-4): 1965 Code of Practice for Concrete Structures for the Storage of Liquids.
5. SP 16:1980 Design Aids for Reinforced Concrete to IS 456:1978.
6. SP 34:1987 Handbook of concrete reinforcement and detailing.

Course Contents and Lecture Schedule

Module No.	TOPICS	No of Lectures
1. Slabs		
1.1	Yield line theory - Analysis and design of square slab	1
1.2	Yield line theory - Analysis and design of rectangular slab	1
1.3	Yield line theory - Analysis and design of circular slab	1
	Tutorial – Design problem	2
1.4	Design of flat slab	1
1.5	Design of grid floor system	1
	Tutorial – Design problem	2
	Tutorial – Reinforcement Detailing of slabs	1
2. Building Frames		
2.1	Analysis and design of a frame using substitute frame method	2
2.2	Analysis and design of a frame using Portal method	1
2.3	Analysis and design of a frame using cantilever method	1

	Tutorial – Design problem	2
	Tutorial – Reinforcement Detailing of frames	1
3. Foundation		
3.1	Design of principles of mat foundation	1
3.2	Design of pile	1
3.3	Design of pile cap	1
	Tutorial – Design problem	2
	Tutorial – Reinforcement Detailing of foundation	1
4. Staircases		
4.1	Design of single flight staircase	1
4.2	Design of dog-legged staircase	1
4.3	Design of stair with stringer beam	1
	Tutorial – Design problem	2
	Tutorial - Reinforcement Detailing of staircases	1
5. Retaining walls		
5.1	Design of cantilever retaining wall	2
	Tutorial – Design problem	2
5.2	Design of counterfort retaining wall	2
	Tutorial – Design problem	2
	Tutorial – Reinforcement Detailing of walls	1
6. Water tanks		
6.1	Design of tank resting on ground	2
6.2	Design of underground water tank	1
	Tutorial – Design problem	2
6.3	Design of elevated water tank	2
	Tutorial – Design problem	2
	Tutorial – Reinforcement Detailing of water tank	1
	Total (Theory = 24; Tutorial = 24)	**48**

Course Designers

Dr. K. Arunachalam karcivil@tce.edu
Dr. M.C. Sundarraja

mcsciv@tce.edu
Mr. D. Rajkumar rajkumarcivil@tce.edu

14CE780 ESTIMATION AND COSTING LAB

Preamble

Category	L	T	P	Credit
PC	0	0	2	1

This lab course focuses on students acquiring knowledge on arriving at quantities of items of works for buildings and road projects. It also gives an exposure to rate analysis for different types of works knowing its specifications.

Prerequisite

Fundamentals of Mathematics, Building materials and technology

Course Outcomes

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

	On successful completion of the course, the students will be able to:		Expected attainment level (%)	Expected proficiency level (grade)
CO1	Explain the general and detailed specifications of different types of construction works	Understand	95	S
CO2	Estimate quantities of items of works for residential buildings with similar foundations for walls -Individual wall method	Apply	95	S
CO3	Estimate quantities of items of works for residential buildings with differential foundations for walls -Individual wall method	Apply	95	S
CO4	Estimate quantities of items of works for residential buildings - Centre line method	Apply	95	S
CO5	Estimate quantities of items of works for roads	Apply	95	S
CO6	Conduct rate analysis for different types of works	Apply	95	S

with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO53	-	L	L	L	-	M	L	M	L	-	M	L	L	L
CO54	S	-	-	L	L	-	-	-	L	L	M	S	M	L
CO55	S	-	-	L	L	-	-	-	L	L	M	S	M	L
CO56	S	-	-	L	L	-	-	-	L	L	M	S	M	L
CO57	S	-	-	L	L	-	-	-	L	L	M	S	M	L
CO58	S	M	L	L	-	L	L	S	L	-	M	S	M	L

S- Strong; M-Medium; L-Low

List of Experiments

1. Writing general specifications for different types of construction works

2. Writing details specifications for different types of construction works

3. Arriving at quantities of items of buildings with similar foundation throughout with flat/sloped roofs using Individual wall method
4. Arriving at quantities of items of buildings with differential foundation details with flat/sloped roofs using Individual wall method using spread sheets
5. Arriving at quantities of items of buildings with similar foundation throughout with flat/sloped roofs using Centre line method
6. Arriving at quantities of items of buildings with differential foundation details with flat/sloped roofs using Centre line method spread sheets
7. Estimation of quantities of items of road works
8. Rate analysis – concept and terminologies, CPWD/ PWD Schedule of rates
9. Arriving at rate per unit of items of plain concrete in different types of foundation, floor and weathering course work
10. Arriving at rate per unit of items of different types of RCC works in structural elements
    – Beams, Columns, slabs etc.
11. Arriving at rate per unit of items of different types of Masonry works (Stone, Brick etc.),
    reinforced brick work
12. Arriving at rate per unit of items of different types of finishing works – plastering, flooring, DPC, pointing, painting etc.

Text Books

1. Dutta B.N., "Estimating and Costing in Civil Engineering: Theory and Practice, Including Specifications and Valuation", UBS Publishers' Distributors, 24th edition, 1998.
2. Chakraborti. M, "Estimating, Costing, Specification & Valuation In Civil Engineering, Vikas Book House, Pune, 2006

Reference Books

1. Robert Peurifoy and Gerold Oberlender "Estimating Construction Costs", Kindle Edition, 2011
2. Govt of Tamil Nadu PWD – "Standard Schedule of Rates", 2016-17

Course Designers

Dr. R. Velkennedy	rvkciv@tce.edu
Dr. G. Chitra	gcciv@tce.edu

14EC7C0	CAPSTONE II

Category	L	T	P	Credit
PC	0	0	2	2

Preamble

The purpose of this course is to apply the concept of mathematics, science and engineering fundamentals and an engineering specialization to solve complex engineering problems.

Course Outcomes

	On the successful completion of the course, students will be able to		**Expected Attainment level in %**	**Expected Proficiency Level in grade**
CO1	Explain the basic concepts of core engineering courses in the programme	Understand	70	A
CO2	Solve complex problems in core engineering courses of the programme	Apply	70	A
CO3	Identify and formulate a complex engineering problem	Analyze	70	A
CO4	Develop solution methodology for the chosen engineering problem	Analyze	70	A
CO5	Provide solution for the chosen engineering problem	Analyze	70	A
CO6	Analyse the performance of the proposed methodology and prepare a technical report	Analyze		

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2
CO1	M	L	-	-	-	-	-	-	-	-	-	S	L	-
CO2	S	M	L	-	-	S	-	-	M	M	-	S	M	M
CO3	S	S	M	L	L	S	M	S	M	M	L	S	S	M
CO4	S	S	M	L	L	M	M	S	S	M	L	S	S	M
CO5	S	S	M	L	L	-	S	S	S	M	L	S	S	M

S- Strong; M-Medium; L-Low

CO6	S	S	M		L	S	S	S	S	S	M	S	S	M

Syllabus

Engineering Group1

Structural Analysis: ILD for indeterminate beams- Strain Energy Method- Theorem of Three Moments- Slope Deflection Method- Moment Distribution Method- Matrix Stiffness Method

Hydraulics and Hydraulic Machinery: Open channel flow- Dimensional Analysis- Impact of jets- Water turbines and Pumps

Wastewater Engineering: Characterization of sewage- Collection of sewage- Transportation of wastewater- Treatment of wastewater- Disposal of sewage.

Engineering Hydrology: Hydrologic processes- Surface runoff- Floods- Groundwater

Soil Mechanics: Physical Properties of soils- Consistency limits- Soil Classification- Permeability- Geostatic Stress- Stress due to applied loads- Shear Strength- Compressibility- Soil Compaction- Stability of Slopes

Highways and Pavement Engineering: Highway planning and Alignment- Geometric Elements- Traffic Engineering- Highway materials- Design of pavements- Highway Construction practice- Highway Maintenance

Engineering Group 2

Design of Masonry, Timber and Steel Elements: Brick masonry- Design of Timber Structures- Bolted connection in steel Structures- Welded connection in steel structures- Steel tension members- Steel compression members- Steel flexure members- Column base

Irrigation and Water Resources Engineering: Water Resources Planning- Irrigation- Dams- Diversion Head works- Cross Drainage works

Design of RC Elements: concept of working stress method, Limit state philosophy as detailed in IS code, Limit state of collapse in flexure, Limit state of collapse in shear and torsion, Limit state of collapse in compression, Limit state of serviceability, Design of footing

Airports, Railways, Docks and Harbour: Permanent Way - its Components and their Functions, Geometric Design of Railway Tracks, Points and Crossings - Design of Turnouts, Working Principle - Signalling, Interlocking and Track Circuiting, Components of Airports, Runway Design - Orientation, Cross wind Component, Wind rose Diagram(Problems), Geometric Design, Requirements of Harbour components

Foundation Engineering: Methods of Site Investigation - Depth of subsurface exploration and Spacing of bore holes - Geophysical methods, Methods of obtaining undisturbed samples, - Bearing Capacities of soils, Types of settlement, functions and types of pile foundation – Bearing capacity failure in piles - Estimating load carrying capacity of piles by Static approach, Efficiency of Pile Group, Drainage and dewatering techniques, Lateral earth Pressure and Retaining Walls.

Design of Steel Structures: Design of welded plate girder, Gantry girder**-** Determination of maximum bending moment and shear force due vertical component of crane wheel load, Design of gantry girder, Beam – Column -behaviour of beam-column - second order moment in beam-column, Design of Truss using Rolled steel sections – Purlins – truss members – Supports. Design of Truss using tubular sections, web angle connection – Beam to Beam Connection - clip and seat Connection – Concept of semi rigid Connection.

Assessment Pattern

(Common to B.E./B.Tech Programmes)

Comprehensive Test (30 Marks)

Test 1: Engineering Group 1 (60 Marks) **Duration: 90 Minutes**

Objective Type Questions : 30

Fill up the blanks : 30

Test 2: Engineering Group 2 (60 Marks) **Duration: 90 Minutes**

Objective Type Questions : 30

Fill up the blanks : 30

Test	Marks Obtained	Converted to
Test1	60 Marks (Max)	15 Marks (Max)
Test 2	60 Marks (Max)	15 Marks (Max)
		30 Marks (Max)

No re-test will be conducted at any circumstances

Complex Engineering Problem Solving (70 Marks):

- Selection of a complex engineering problem (Batch size: 2-4) : 5 Marks
- Literature Survey : 5 Marks
- Problem Formulation : 10 Marks
- Solution Methodology : 15 Marks
- Results and Discussion : 15 Marks

- Technical Report : 10 Marks
- Viva Voce : 10 Marks

Course Designers:

Dr. T. Baskaran tbciv@tce.edu

Dr. R. Velkennedy rvkciv@tce.edu

Dr. D. Brindha dbciv@tce.edu

Mr. R. Sanjaykumar ravirajsanjay@gmail.com

14CEPA0	**MUNICIPAL SOLID WASTE MANAGEMENT**	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course provides an in-depth understanding of solid waste characteristics and management. The students acquire proficiency in processing and safe disposal of municipal solid waste generated by a community.

Course Outcomes

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

			Expected Attainment Level (%)	Expect Profici Level(
CO1	Analyze the composition of solid waste generated from the community	Apply	70	A
CO2	Understand the functional elements of municipal solid waste management system	Apply	70	A
CO3	Analyze the collection methods and transport modes of generated solid waste	Apply	70	A
CO4	Evaluate the various processing technologies for Municipal solid waste management	Apply	70	A
CO5	Analyze the options to recover energy from waste generated	Apply	70	A
CO6	Suggest appropriate disposal methods for environmental safety	Apply	70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO44.	M	-	-	M	-	M	L	-	-	M	-	-	L	L
CO45.	M	M	-	-	-	M	M	-	-	L	-	-	L	L
CO3	L	M	S	M	-	M	M	M	-	M	-	-	M	M
CO4	M	M	S	M	-	-	S	-	-	-	-	-	M	L
CO5	M	M	S	M	-	M	S	-	M	M	-	M	M	M
CO6	M	M	S	M	-	M	S	M	M	M	-	M	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	**20**	**20**	**20**	**20**
Understand	**40**	**40**	**40**	**40**
Apply	**40**	**40**	**40**	**40**
Analyse	**-**	**-**	**-**	**-**
Evaluate	**-**	**-**	**-**	**-**
Create	**-**	**-**	**-**	**-**

Course Level Assessment Questions

Course Outcome 1 (CO1):

46. **List the chemical characteristics of Municipal Solid Waste.**

47. **List the essential functional elements in MSW.**
48. **Explain the concept of Integrated Solid Waste Management?**

Course Outcome 2 (CO2)

1. **State the factors to be considered while finalizing the collection route.**
2. **Write down the factors influencing the selection of location for transfer station.**
3. **List and discuss the types of containers and collection vehicles used for solid waste management.**

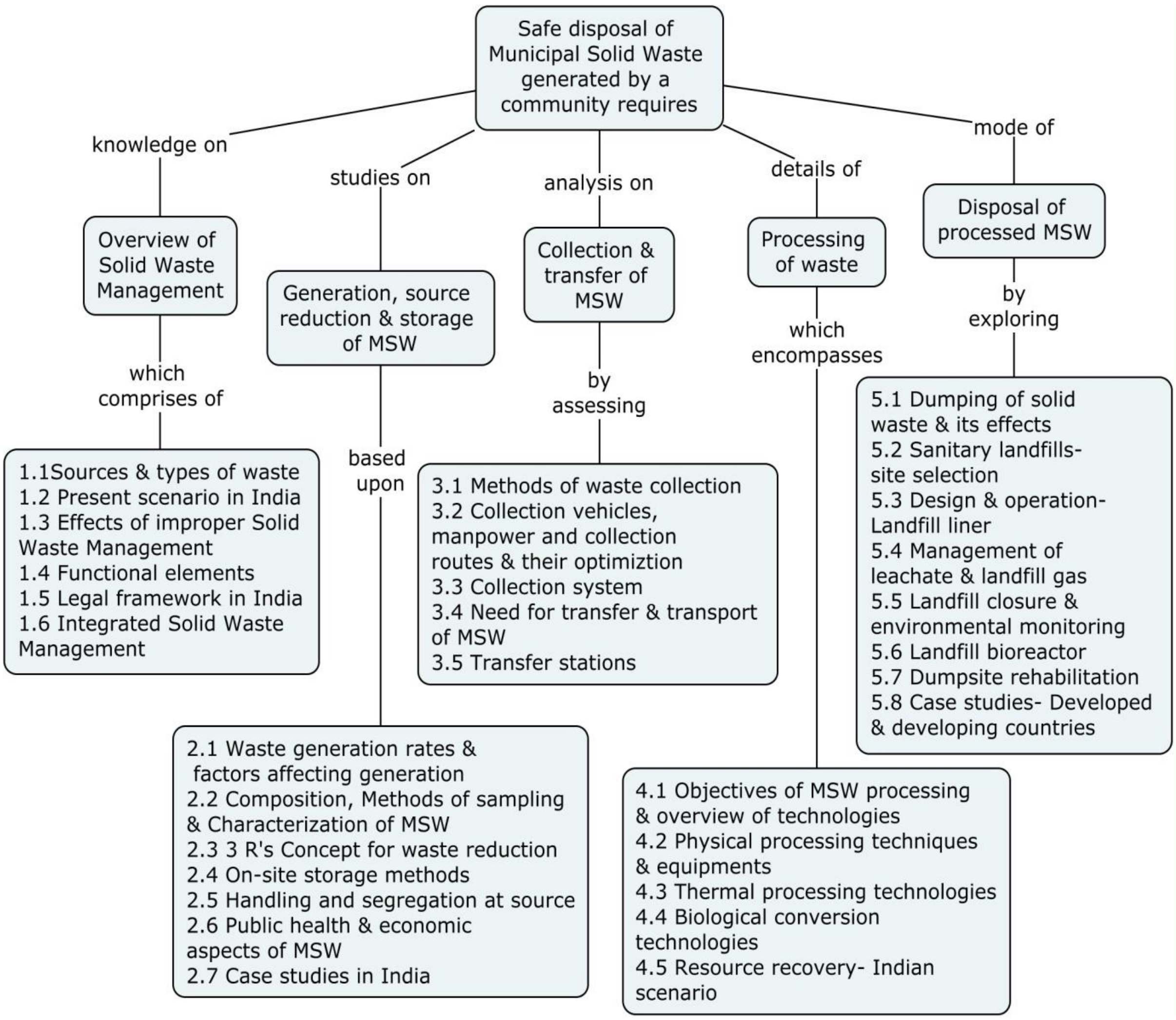
Course Outcome 3 (CO3)

49. **Assess the techno-economic viability of various processing techniques.**
50. **Compare the environmental effects of composting and bio-gasification.**
51. **Assess the energy generation potential of MSW.**

Course Outcome 4 (CO4)

1. Suggest the best disposal option for the municipal solid waste generated from your locality.
2. Discuss the various issues faced by municipal authorities in identifying the disposal site.
3. Do you think a sanitary landfill is possible to manage wastes in your locality? List at least three reasons to support your answer.

Concept Map



Syllabus

Overview of Solid Waste Management Sources and types; Present scenario in India; Elements of Solid Waste Management; Legal framework in India; Integrated Solid Waste Management. **Generation, Source reduction & Storage of MSW** Waste generation rates and factors affecting generation; Composition, Method of sampling and characteristics; Source reduction and 3 R’s concept; On-site storage methods and materials used; Handling and segregation at source; Public health and economic aspects of open storage; Case studies on Indian conditions. **Collection and Transfer of MSW** Methods of collection; Collection vehicles and manpower; Collection routes and their optimization; Analysis of collection systems; Need for transfer and transport of MSW; Transfer station. **Processing of MSW Objectives of MSW** Objectives & overview; Physical processing techniques and equipments; Thermal processing technologies; Biological conversion technologies; Resource recovery from solid waste. **Disposal of processed MSW** Dumping of solid waste and its effects; Sanitary Landfills; Design and Operation of Landfill liner; Management of leachate and landfill gas; Landfill closure and environmental monitoring; Landfill bioreactor; Dumpsite rehabilitation; Case studies on developed and developing countries.

Text Book

1. George Tchobanoglous, Hilary Thiesen and Samuel A Vigil, “Integrated Solid Waste Management: Engineering Principles and Management Issues”, McGraw Hill Publishers, New York, 1993.

Reference Books

40. “Manual on Municipal Solid Waste Management”, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2000.
41. Bhide, A. D. and Sundaresan, B. B. “Solid Waste Management Collection, Processing and Disposal”, ISBN 81-7525-282-0, 2001.
42. Paul T Williams, “Waste Treatment and Disposal”, John Wiley and Sons, England, 2005.

Course Contents and Lecture Schedule

S. No	Topics	Periods
	1.0 Overview of Solid Waste Management	
1.1	Sources and types of solid waste	2
1.2	Present scenario of Solid Waste Management in India	1
1.3	Effects of improper Solid Waste Management	1
1.4	Elements of Solid Waste Management	1
1.5	Legal framework for Solid Waste Management in India	1
1.6	Integrated Solid Waste Management- Public Awareness and Role of NGO’s	1
	2.0 Generation, Source reduction & Storage of MSW	
2.1	Waste generation rates and factors affecting generation	1
2.2	Composition, Method of sampling and characteristics of MSW	2
2.3	Source reduction of waste and 3 R’s concept for waste reduction	1
2.4	On-site storage methods and materials used for containers	1
2.5	Handling and segregation of waste at source	1
2.6	Public health and economic aspects of open storage	1
2.7	Case studies on Indian conditions	1
	3.0 Collection and Transfer of MSW	

3.1	Methods of collection of waste	1
3.2	Collection vehicles, manpower and collection routes & their optimization	1
3.3	Analysis of collection systems	1
3.4	Need for transfer and transport of MSW	1
3.5	Transfer station- Selection of location, operation and maintenance	1
	4.0 Processing of MSW	
4.1	Objectives of MSW processing and overview of processing technologies	1
4.2	Physical processing techniques and equipments	1
4.3	Thermal processing technologies	2
4.4	Biological conversion technologies- Biomethanation and Composting	2
4.5	Resource recovery from solid waste- Case studies on Indian conditions	1
	5.0 Disposal of processed MSW	
5.1	Dumping of solid waste and its effects on environment	1
5.2	Sanitary Landfills- site selection	1
5.3	Design and Operation- Landfill liner	2
5.4	Management of leachate and landfill gas	1
5.5	Landfill closure and environmental monitoring	1
5.6	Landfill bioreactor	1
5.7	Dumpsite rehabilitation	1
5.8	Case studies on developed and developing countries	1
	TOTAL	**36**

Course Designers:

1. Dr. T. Vel Rajan tvciv@tce.edu
2. Mr. V. Ravi Sankar environmentengr@tce.edu
3. Ms. N. Brinda Lakshmi brinda.nlakshmi@gmail.com

14CEPB1	AIR AND NOISE POLLUTION MANAGEMENT	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

The course work offers the basic knowledge on various sources of air pollutants and their possible effects on local, regional and global environment. It provides various techniques for sampling and analyzingthe pollutants. Also, it deals with the principles and design of control of particulate/gaseous air pollutants and its emerging trends to fulfil the legal aspects of air pollution to have a sustainable environment for future generation. In addition, this course imparts knowledge about the fundamental theory of sound, noise pollution sources with its effects and control techniques.

Prerequisite

Nil

Course Outcomes

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

			Expected Attainment level(%)	Expected Proficiency level(grade)
CO1	Identify the sources of air pollution, impacts of air pollutants and their measurements	Understand	70	A
CO2	Identify the significance of meteorological factors in pollutants dispersion and to predict the pollutant concentration	Apply	70	A
CO3	Suggest preventive and control measures for air pollution.	Apply	70	A
CO4	Suggest locations for industries and appropriate city planning tips for the effective air pollution management of a city.	Apply	70	A
CO5	Identify the sources of noise and its impacts on human beings	Understand	70	A
CO6	Suggest different noise control measures.	Apply	70	A

Mapping with Programme Outcomes

COs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1.	M	M	L	L	-	M	M	-	M	-	-	-	M	L
CO2.	S	S	M	S	-	M	M	-	-	-	-	-	M	L
CO3	S	S	S	S	-	-	S	-	-	-	-	-	M	L

CO4	L	S	S	S	-	S	S	S	S	S	-	S	M	M
CO5	M	L	L	L	-	M	M	-	M	-	-	-	L	L
CO6	S	M	S	S	-	-	S	-	-	-	-	-	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	**20**	**20**	**20**	**20**
Understand	**60**	**40**	**40**	**40**
Apply	**-**	**40**	**40**	**40**
Analyse	**-**	**-**	**-**	**-**
Evaluate	**-**	**-**	**-**	**-**
Create	**-**	**-**	**-**	**-**

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. Define Air Pollution.
2. Name some Green House Gases.
3. Explain the classification of Air Pollutants.
4. Explain the sources of Air Pollutants.
5. Explain Global Warming.
6. Illustrate a plan for an ambient air quality sampling in your city.

Course Outcome 2 (CO2)

1. Define Plume.
2. Demonstrate, how prevailing lapse rate affect the plume behaviour from a stack.
3. Summarize various meteorological factors that affect the transport process of air pollutants.
4. Explain the mechanism of dispersion of air pollutants.
5. Construct the Gaussian dispersion model for the pollutants from a point source.
6. Identify the maximum NO_x concentration at ground level and also at 50m above ground for a dumpsite fire which emits 3g/s of NO_x, Determine the NO_x concentration at 2km downwind if the wind speed U10=5 m/s and the stability is class D.
7. Solve for the maximum ground level concentration of SO_2 at 10km from the plant for a 915 MW power plant with a load factor of 72.5% and efficiency of 40% uses coal as a fuel source. The coal has 1% sulphur content and a calorific value of 30 MJ/kg. The stack tip is 200m high with a diameter of 7m. If neutral condition prevails and take U_{10}=4 m/s, T_S=150°C T_a=20°C and V_S=15 m/s.

Course Outcome 3 (CO3)

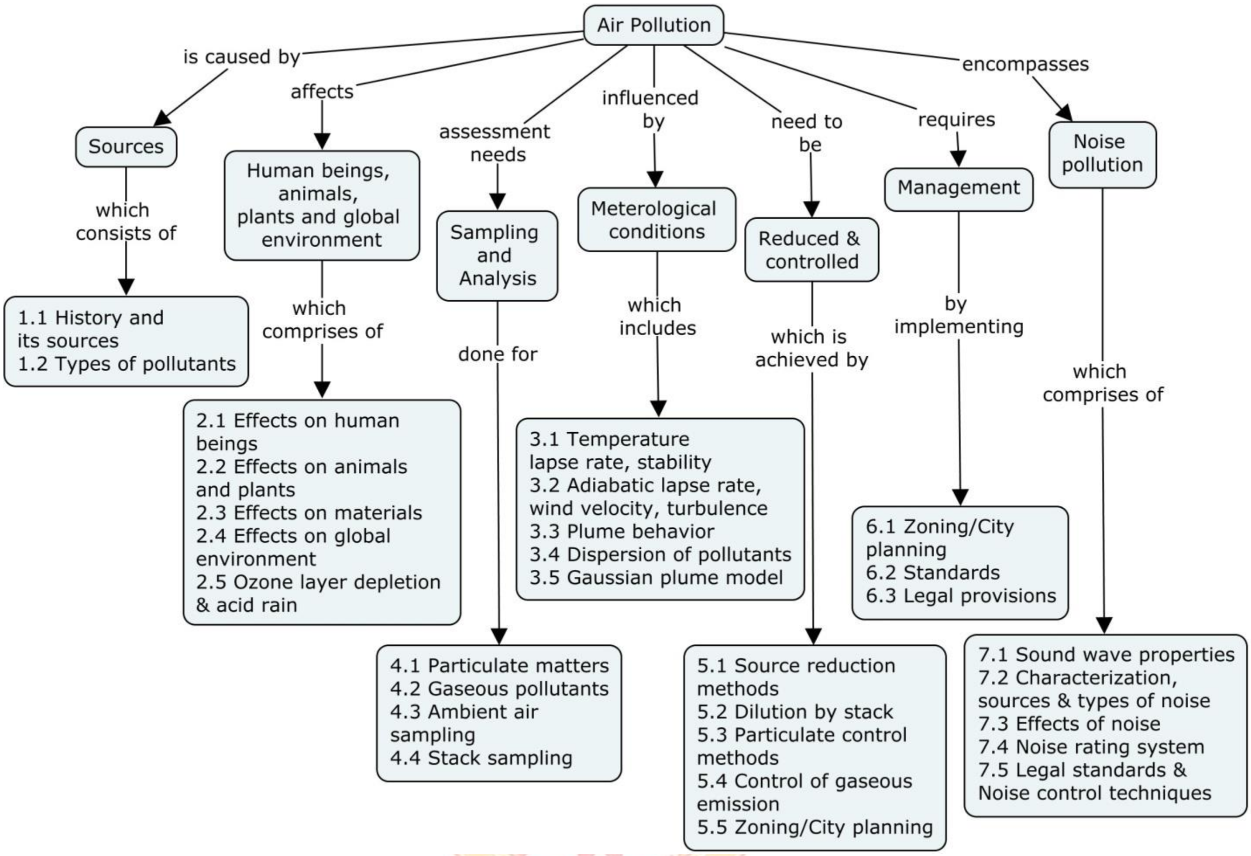
1. Explain the working principle of an ESP and state the factors governing its performances.
2. Explain the control strategies in automotive pollution.
3. Identifythe various possible source reduction methods in the control of air pollution.
4. Develop the size of a cyclone that will remove a 15µm particle with 50% efficiency from an air stream of 6.0 m^3/min. The temperature of the air is 75°C and the specific gravity of the particle is 1.50. Assume five turns.
5. Solve for the new collection efficiency of a cross flow scrubber with a new spray nozzle system installed that make all the water drops to 200µm in diameter which

earlier collects 90% of the 3µm particle having the water drops of diameter, 400µm.. The flow is same.

Course Outcome 4 (CO4)

1. Explain the properties and characteristics of sound.
2. Define noise pollution. What are the sources for noise pollution?
3. Explain the impacts of noise on human beings. How could it be controlled?
4. Identify the Lequ of an air conditioner which generates a noise level of 75 dB for five minutes every hour and the background noise level is 55 dB.

Concept Map



Syllabus

Introduction to Air pollution– Particulates and Gaseous pollutants - sources, classification and types of air pollutants, Effects and Impacts of Air pollution on environment; Sampling and Analysis techniques.**Meteorological factors –** Dispersion,Factors affecting dispersion, Plume rise & behaviour and Modelling techniques; **Reduction and control methods –** source reduction and by equipment control; Automotive pollutions control; **Air pollution management -** Air quality standards,emission standards, indices, industrial plant locations, city planning, air pollution legislation and regulations – air pollution survey; **Noise pollution**– Properties& Characteristics of sound waves; Noise sources,effects; Hearing - mechanism, impairment, speech interference, sleep interference; Noise rating system; Standards for ambient and workspace noise levels, Noise control techniques at source, transmission path &at receiver end.

Text Book

1. Rao M.N and Rao H.V.N, “Air pollution”, Tata McGraw Publishers, 2006.
2. Mahajan, S. P., “Air Pollution Control”, TERI Press, New Delhi, 2009.

Reference Books

1. Noel de Nevers, “Air pollution control engineering”, McGraw Hill, New York, 2000.
2. Lawrence K.Wang, Norman C Pererla, Yung – Tse Hung, “Air pollution Control Engineering”, Tokyo, 2004
3. David H.F Liu, BelaG.Liptak “Air pollution”, Lewis publishers, 2000.
4. Anjaneyalu Y, “Air pollution and control technologies”, Allied Publishers (P) Ltd. India, 2002.
5. Mackenzie L Davis and David A Cornwell, “Introduction of Environmental Engineering” McGraw Hill Publishers, 1998.

Course Contents and Lecture Schedule

Module No	Topics	No. of Lectures
1.0	**Introduction to Air pollution**	
1.1	History of air pollution- Sources of air pollution	1
1.2	Types of pollutants	1
2.0	**Effects of air pollutants**	
2.1	Effects of air pollutants on human beings	2
2.2	Effects of air pollutants on animals and plants	1
2.3	Effects of air pollutants on materials	1
2.4	Effects of air pollutants on global environment – Global warming	1
2.5	Ozone layer depletion, acid rain	1
3.0	**Sampling and analysis**	
3.1	Sampling and measurement of particulate matters	1
3.2	Sampling and measurement of gaseous matters	1
3.3	Ambient air sampling, analysis of air pollutants- chemical and instrumental methods	1
3.4	Stack sampling	1
4.0	**Meteorological conditions**	
4.1	Temperature lapse rate, stability	1
4.2	Adiabatic lapse rate, wind velocity and turbulence	1
4.3	Plume behaviour	1
4.4	Dispersion of air pollutants- maximum mixing depth, dispersion model	2
4.5	Gaussian plume model and plume rise- problems	2
5.0	**Reduction and control methods**	
5.1	Source reduction methods	1
5.2	Dilution by stack	1
5.3	Control by equipments- Particulate control methods	3
5.4	Control of gaseous emissions	3
5.5	Control of automotive pollution	1
6.0	**Air pollution management**	
6.1	Zoning/City planning, Industrial plant location	1
6.2	Air quality and emission standards	1
6.3	Legal provision	1
7.0	**Noise pollution**	
7.1	Sound wave properties	1
7.2	Characteristics, sources & types of noise	1

Category L T P Credit

7.3	Effects of noise	1
7.4	Noise rating system	1
7.5	Legal standards and noise control techniques	1
	TOTAL	**36**

Course designers

1. Dr. T. VelRajan tvciv@tce.edu
2. Mr. R. K. C. Jeykumar rkcjey@tce.edu
3. Ms. N. Brinda Lakshmi brinda.nlakshmi@gmail.com

14CEPC0 **FINITE ELEMENT ANALYSIS** PC 3 0 0 3

Preamble

This course provides an introduction to the finite element analysis, from engineering rather than a purely mathematical point of view.

Prerequisite

Fundamentals of Mathematics, knowledge of forces and resolution and equilibrium concepts.

Course Outcomes

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

			Expected Attainment Level (%)	Expected proficiency level(grade)
CO1	Analyze the potential energy functions of equilibrium and weak formulation	Apply	70	A
CO2	Compute the stresses and reaction forces in 1D Bar Element	Apply	70	A
CO3	Calculate the stresses and reaction forces in Truss Element	Apply	70	A
CO4	Analyze the constant strain triangle and iso parametric elements	Apply	70	A
CO5	Analyze Gaussian quadrature of one and two dimensional problems	Apply	70	A

Mapping with Programme Outcomes

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO3.	S	S	S	S	-	-	-	-	-	-	S	-	L	L
CO4.	S	S	S	S	-	-	-	-	-	-	S	-	L	L
CO3	S	S	S	S	-	-	-	-	-	-	S	-	L	L
CO4	S	S	S	S	-	-	-	-	-	-	S	-	L	L
CO5	S	S	S	S	-	-	-	-	-	-	S	-	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	20	20	20	20
Apply	70	70	70	70
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Course Level Assessment Questions

CO1: Analyze the potential energy functions of equilibrium and weak formulation

1. Compare internal and external forces with examples.
2. Compute the deflection at the centre of a simply supported beam subjected to uniformly distributed load over the entire span, Using Rayleigh Ritz method.
3. Discuss weighted integral and weak formulation with examples.
4. Compute the deflection of cantilever beam subjected to uniformly distributed load over the entire span, Using Rayleigh Ritz method.
5. State theorem of minimum potential energy.
6. Discuss weighted integral and weak formulation with examples.

CO2: Compute the stresses and reaction forces in 1D Bar Element

1. Calculate the nodal displacement, stresses in each element and reaction forces.($E=2x10^5$ N/mm^2). Axial force P=20N is applied as shown in Fig.

2. Show the nodal displacements, element stresses and reaction force for the bar shown in

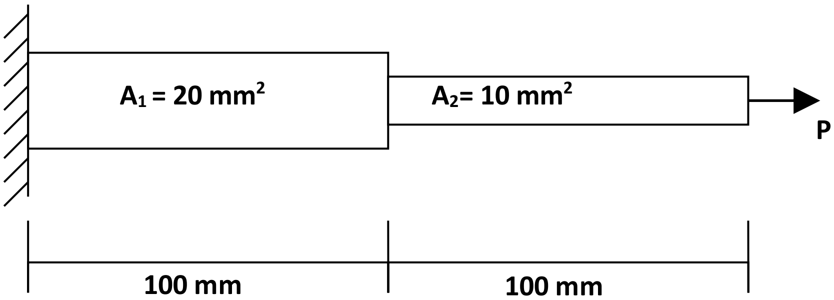
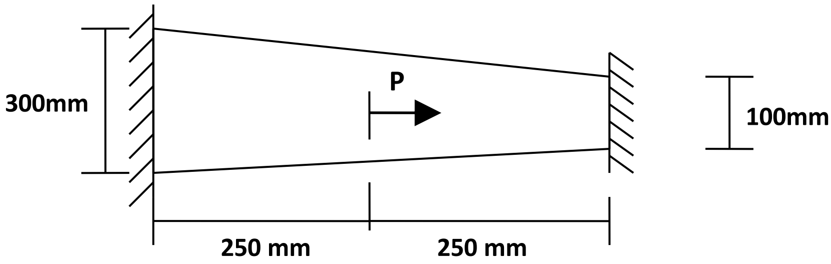


Fig.

Fig. P = 30kN



Thickness = 25mm

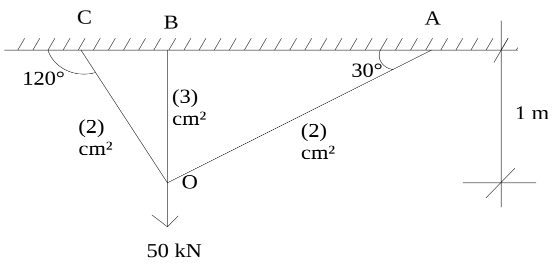
E = 2x10^5 N/mm^2

Fig.

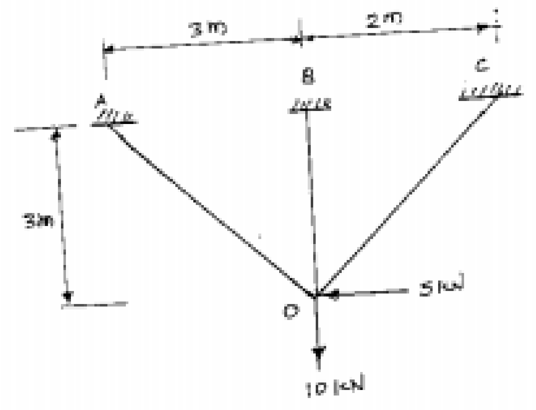
3. Deduce the element stiffness matrix and shape function for one dimensional bar element.

CO3: Calculate the stresses and reaction forces in Truss Element

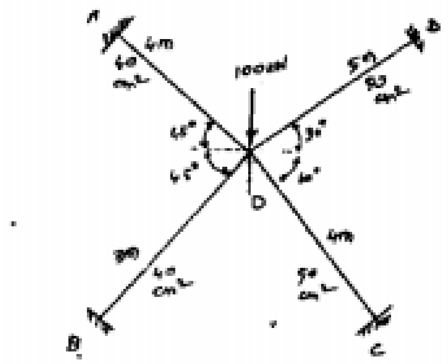
1. Evaluate the forces in the members of the truss shown in Fig by finite element method. Take E = 200 GPa.



2. Evaluate the forces in the members of the truss shown in Fig by finite element method. Take E = 200 GPa.

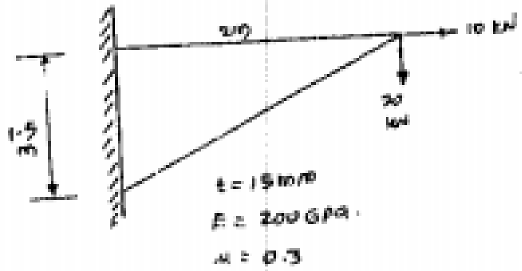


3. Evaluate the forces in the members of the truss shown in Fig by finite element method. Take E = 200 GPa.



CO4: Analyze the constant strain triangle and Isoparametric elements

1. Calculate the displacements of nodes 1 and 2 and the element stresses using plane stress conditions. Body force may be neglected in comparison with the external forces.
2. Differentiate plane stress and plane strain problem with examples.
3. Deduce the expression for shape function, strain displacement matrices and stiffness matrix for a CST element .
4. Deduce the expression for the jacobian of transformation matrix of a triangular element
5. Calculate the displacements of nodes 1 and 2 and the element stresses using plane stress conditions. Body force may be neglected in comparison with the external forces



CO5 Analyze Gaussian quadrature of one and two dimensional problems

1. Solve the integral $\int 3e^{x} + x^{2} + \frac{1}{x+2}dx$ using one point and two point Gauss quadrature formula

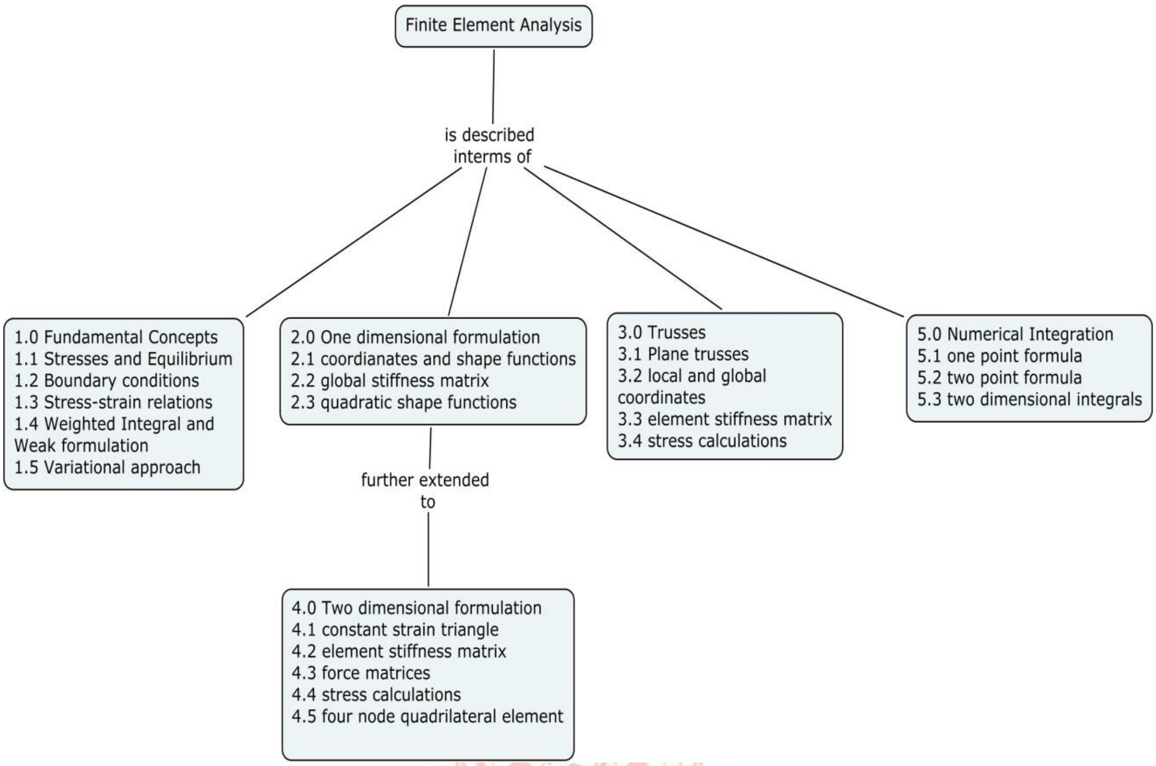
2. Compute the direct strain at x and y and shear strain at the point x = 1, y=0. If a displacement field is described by

   $u = (-x^2 + 2y^2 + 6xy)\ 10^{-4}$

   $v = (3x + 6y - y^2)\ 10^{-4}$

3. Solve $\int_{-1}^{1}\int_{-1}^{1}(x^{2} + y^{2} + 2xy)dxdy$ using Gauss numerical integration.

Concept Map



Syllabus

Fundamental Concepts: Stresses and equilibrium – Boundary conditions – strain-displacement relations – stress-strain relations – potential energy and equilibrium – weighted integral and weak formulation – variational approach **One dimensional formulation:** Finite element modeling – coordinates and shapes functions – Assembly of global stiffness matrix and global load vector – properties of K – finite element equations – treatment of boundary conditions – quadratic shape functions – temperature effects. **Trusses:** Plane trusses – local –global transformation - stiffness matrix – stress calculations.**Two dimensional formulation:** Finite element modeling – constant strain triangle – problem modeling and boundary conditions - stress calculations –Isoparametric elements – four node quadrilateral and nine node quadrilateral elements-**Numerical Integration**-One point formula and two point formula – two dimensional integrals.

Text Books

1. Tirupathi R. Chandrupatla, Ashok D. Belegundu, "Introduction to finite elements in engineering" Fourth Edition , Prentice Hall of India, New Delhi, 2012.
2. Krishnamoorthy,C.S, "Finite Element Analysis Theory and Programming" Second Edition, Tata McGraw Hill Publishing Co.Ltd. New Delhi 2004.
3. P. Seshu, "Textbook Of Finite Element Analysis " Prentice Hall of India Learning Pvt. Ltd. 2003

References

1. David V. Hutton "Fundamentals of Finite Element Analysis 1st Edition" Tata McGraw Hill Publishing Co.Ltd. New Delhi 2003.
2. Moaveni,S., Finite Element Analysis : Theory and Application with ANSYS, Prentice Hall Inc., 1999.
3. G. Ramamurty, "Applied Finite Element Analysis" I. K. International publishing house Pvt Ltd. 2010.
4. Zienkiewicz, O.C, and Taylor, R.L., The Finite Elements Methods , Mc Graw Hill , 6th edition 1987.
5. Singiresu S. Rao, Singiresu S. RAO "The Finite Element Method in Engineering" Elsevier Butterworth-Heinemann 2005
6. http://nptel.ac.in/courses/112104116/
7. http://nptel.ac.in/courses/105106051/
8. http://nptel.ac.in/courses/112104115/

Course Contents and Lecture Schedule

S.NO	TOPICS	NO. OF HOURS
1	**Fundamental Concepts**	
1.1	Introduction- Stresses and equilibrium	1
1.2	Boundary conditions	1
1.3	strain-displacement relations, Stress – strain relations – potential energy and equilibrium	1
1.4	Weighted Integral and Weak formulation	1
1.5	Variational Approach- Rayleigh Ritz method- Galerkin method	1
	Tutorial- Variational Approach and Weak formulation	2
2	**One dimensional formulation**	
2.1	Introduction – Finite Element Modelling, coordinates and shape functions	1
2.2	Assembly of Global Stiffness Matrix and Load Vector- Properties of K, finite element equations and treatment of boundary conditions	2
2.3	Quadratic shape functions, temperature effects	1
	Tutorial - One dimensional problems	3
3	**Trusses**	

3.1	Introduction – Plane trusses	1
3.2	Local and global coordinate systems	1
3.3	Element stiffness matrix	1
3.4	stress calculations for truss elements	1
	Tutorial - Truss problems	3
4	**Two dimensional formulation**	
4.1	Introduction of two dimensional problems- Constant strain triangle	1
4.2	Constant strain triangle- Element stiffness matrix	1
4.3	Constant strain triangle- force matrix	1
4.4	Constant strain triangle- stress calculation	1
	Tutorial – two dimensional problems	3
4.5	Four node and Nine node quadrilateral elements-Higher order elements	2
5	**Numerical Integration**	
5.1	Gauss Qudrature- One point formula	1
	Tutorial -- One point formula	1
5.2	Gauss Qudrature -two point formula	1
	Tutorial-- Two point formula	1
5.3	Two dimensional integrals	1
	Tutorial – Two dimensional integrals	1
	Total Hours	**36**

Course Designer

1. Dr.S.Nagan nagan_civil@tce.edu

14CEPD0	BASICS OF REMOTE SENSING	Category	L	T	P	Credit
		PC	3	0	0	3

Preamble

Remote sensing is the science and art of obtaining information about an object, area or phenomenon, by the use of either recording or real time sensing devices that are not in physical contact with the object. The Global Positioning System (GPS) is a satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense. These GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to earth. Remote sensing and GPS data are further used in numerous applications, including GIS data collection, surveying, and mapping.

Prerequisite

Fundamental of Physics, Mathematics, Geography, Geology and Surveying

Course Outcomes

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

		Expected Attainment Level(%)	Expected Proficien Level(gra
CO1 Recollect the fundamentals of physics of Remote sensing and concepts.	Remember	70	A
CO2 Outline the various data acquisition systems and collection methods for remote sensing data information and storage.	Understand	70	A
CO3 Apply knowledge of satellites on various Civil Engineering applications.	Apply	70	A
CO4 Utilize the various data input methods for mapping	Apply	70	A
CO5 Creation of data models using remote sensing techniques and GPS	Apply	70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	S	-	-	-	-	-	-	-	-	-	-	-	-	-

CO3	S	-	-	-	-	-	-	-	-	-	-	-	L	-
CO4	S	L	-	-	L	-	-	-	L	L	L	-	L	L
CO5	S	L	-	-	L	-	-	-	L	L	L	-	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	**50**	**20**	**20**	**20**
Understand	**50**	**40**	**40**	**40**
Apply	**0**	**40**	**40**	**40**
Analyse	**0**	**0**	**0**	**0**
Evaluate	**0**	**0**	**0**	**0**
Create	**0**	**0**	**0**	**0**

Course Level Assessment Questions

Course Outcome 1 (CO1):

52. **Define Plank's law.**
53. **List the types of scattering.**
54. **Define EMR.**
55. **What is black body radiation?**
56. **How absorption affects remote sensing data quality?**
57. **Define GPS.**
58. **What is data?**
59. **List the important types of GPS.**
60. **List the various remote sensing platforms.**

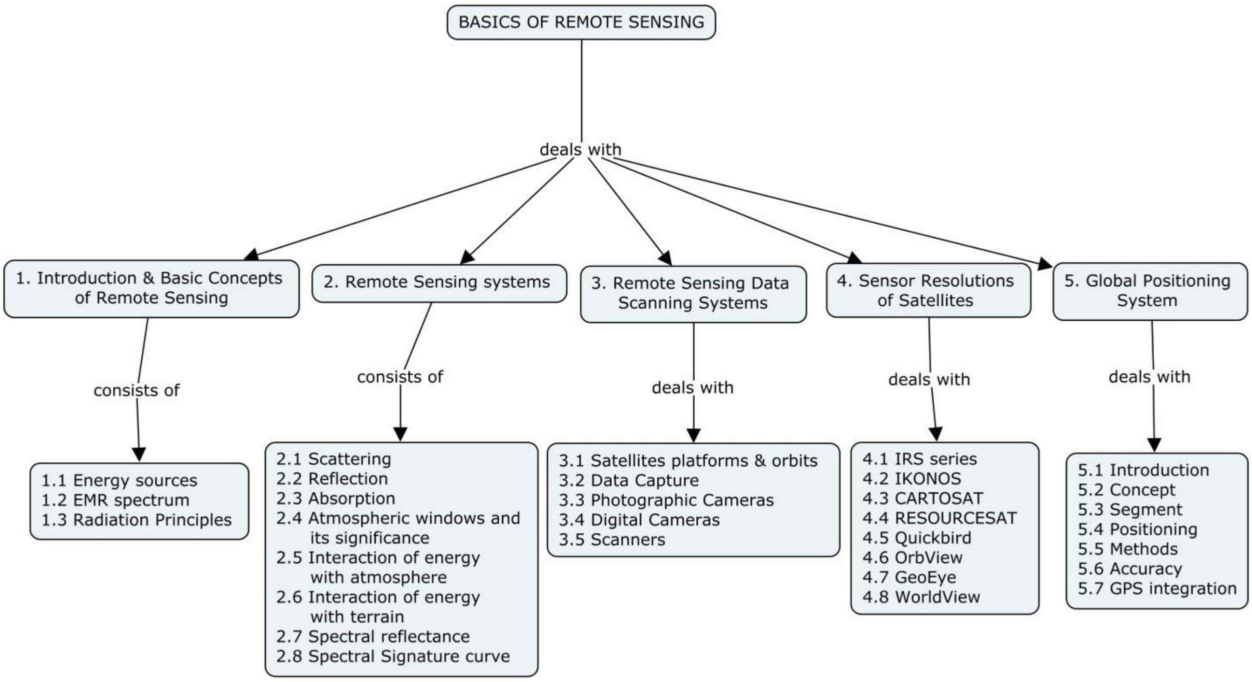
Course Outcome 2 (CO2):

61. **Discuss how remote sensing data quality is affected by energy interaction with atmosphere.**
62. **Discuss how remote sensing data quality is affected by energy interaction with earth surface materials.**
63. **Describe the importance of sensors resolutions in data interpretation.**
64. **Summarize atmospheric windows and its significance.**
65. **Describe various sensors resolutions.**
66. **Discuss CARTOSAT and RESOURSESATsatellites sensor characteristics.**
67. **Write various segments of GPS and its importance.**

Course Outcome 3 (CO3):

68. **Discuss the radiation principles and its application in remote sensing data capturing.**
69. **Write spectral reflectance of various objects and discuss how image interpretation is done with respect to different wave length of EMR.**
70. **Explain in detail the development in the IRS series with respect to spatial resolution.**
71. **Describe GPS structure and also discuss its merits and demerits.**
72. **Describe GPS surveying methods and accuracy.**
73. **Discuss about GPS positioning and its importance.**

Concept Map



Syllabus

Introduction and Basic Conceptsof Remote Sensing–Sources - EMR spectrum - Radiation Principles **Remote Sensingsystems**- Scattering – Reflection – Absorption - Atmospheric windows and its significance – Interaction of energy with atmosphere – Interaction of energy with terrain. Spectral Reflectance – Spectral Signature curve. **Remote Sensing Data Scanning Systems**-Satellites platforms and orbits -Data Capture - Photographic Cameras - Digital Cameras –Scanners. **Sensor Resolutionsof Satellites**– IRS series – IKONOS, CARTOSAT – RESOURCESAT, Quickbird, OrbView, GeoEye, WorldView.**Global Positioning System**– Introduction– Concept - Segment - Positioning – Methods – Accuracy- GPS integration.

Text Book

Lillesand, Thomas, Ralph W. Kiefer, and Jonathan Chipman. Remote sensing and image interpretation, John Wiley & Sons, 2014.

Hofmann-Wellenhof, B., Lichtenegger, H., & Collins, J. Global positioning system: theory and practice, Springer Science & Business Media, 2012.

Reference Books

Jensen, John R. Remote sensing of the environment: An earth resource perspective 2nd edition, Pearson Education India, 2009.

Campbell, James B., and Randolph H. Wynne. Introduction to remote sensing. Guilford Press, 2011.

El-Rabbany, A. Introduction to GPS: the global positioning system, Artech House, 2002.

Gopi, S. Global positioning System: Principles and applications, Tata McGraw-Hill Education, 2005.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	**Introduction and basic concepts of Remote Sensing**	
1.1	**Definitions and Energy sources**	**1**
1.2	**EMR spectrum –wavelength and frequency, regions and its properties**	**1**
1.3	**Radiation laws – Plank's, Stefen, Kirchhoff's law and Boltzman law, radiant and kinetic temperature**	**1**
1.4	**Black body radiation**	**1**
2.	**Remote Sensing systems**	
2.1	**Scattering – Raleigh, Mie and Non-selective scattering**	**1**
2.2	**Reflection and absorption – types of reflecting surfaces and variations in absoption level by various objects and its controlling facotrs**	**1**
2.3	**Atmospheric windows and its significance**	**1**
2.4	Interaction of energy with atmosphere - Scattering, absorption, transmission, atmospheric windows	**1**
2.5	**Interaction of energy with terrain – water,ice, vegetation, soils, minerals and rocks.**	**1**
2.6	**Spectral reflectance and concept of signature**	**1**
2.7	**Spectral signature and curve**	**1**
3.	**Remote Sensing Data Scanning Systems**	
3.1	Platforms - Ground, Airborne and Space borne	**1**
3.2	Orbital Characteristics – Coverage, Passes, Pointing Accuracy, Geostationary, sun synchronous, shuttle orbit. Semisynchronous orbit (Molniya orbit) and Quasi - zenith satellite orbit	**1**
3.3	**Whiskbroom scanners, Pushbroom scanners, Side looking scanners, Multi and Hyperspectral scanners.**	**1**
3.4	Types and Characteristics of Sensors - Imaging and non - imaging sensors, Active and passive sensors	**1**
4.	**Sensor Resolutions of Satellites**	
4.1	Spectral, Spatial, Radiometric & Temporal resolutions	**2**
4.2	**IRS series – IRS – 1A and IRS – 1B sensors resolutions**	**1**
4.3	**IRS series – IRS – 1C and IRS – 1D sensors resolutions**	**1**
4.4	**OCEANSAT – CARTOSAT – RESOURCESAT sensors resolutions**	**1**
4.5	**Sensors resolutions of IKONOS, Quickbird, OrbView, GeoEye, WorldView**	**1**
4.6	**Other important earth and space imaging satellite sensors resolutions**	**1**
5.	**Global Positioning System**	
5.1	Introduction to GPS, Reference Systems and Coordinate systems: Geodetic coordinate systems, Datum transformations, Height systems, Time systems	**2**
5.2	Satellite Navigations constellations and Geopositioning	**2**
5.3	Basic Concepts - NAVSTAR, GLONASS, Indian Regional navigational	**2**

Module No.	Topic	No. of Lectures
	Satellite System (IRNSS)	
5.4	**Control Segment, Space Segments, User Segment**	**2**
5.5	GPS Positioning Types-Absolute Positioning,Differential positioning.	**2**
5.6	GPS Surveying Methods and Accuracy - Static & Rapid Static, Kinematic-Real Time Kinematic Survey –DGPS-GPS Data Processing and Accuracy	**2**
5.7	GPS integration- GPSLRF, GPSINS, GPS pseudolite, cellular integration.	**2**
	Total Periods	**36**

Course Designers:

1. Dr.S.Palanivel spciv@tce.edu
2. Dr.D.P.Vijayalakshmi dpviji@tce.edu

14CEPE0	DYNAMICS OF STRUCTURES	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course deals with the dynamic analysis of various degrees of freedom system. The dynamic response of single degree of freedom system with damping subjected to harmonic excitation. This course deals with the response of linear two and multi degree of freedom systems with regard to natural frequencies and mode shapes. This course also deals with base isolation technique and dynamic analysis of machine foundation.

Prerequisite

Fundamentals of Mathematics, knowledge of basic Sciences.

Course Outcomes

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

			Expected Attainment level (%)	Expected Proficiency level (grade)
CO1	Explain the concepts of single degree of freedom with free vibration.	Analyse	70	A
CO2	Analyse the single degree of freedom forced vibration with harmonic excitation.	Analyse	70	A
CO3	Interpret the two degree of freedom under free vibration with built structures.	Analyse	70	A
CO4	Analyse the two degree of freedom for forced vibration with harmonic excitation.	Analyse	70	A
CO5	Analyse the Multi degree of freedom with free and forced vibration.	Analyse	70	A
CO6	Perform dynamic analysis of RC structures	Apply	70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO5.	S	M	-	-	-	-	-	-	-	L	-	-	M	L
CO6.	M	S	-	-	-	-	-	-	-	L	-	-	M	L
CO3.	M	S	-	-	-	-	-	-	-	L	-	-	M	L
CO4.	M	S	-	-	-	-	-	-	-	L	-	-	M	L
CO5.	M	S	-	-	-	-	-	-	-	L	-	-	M	L
CO6.	M	S	-	-	-	-	-	-	-	L	-	-	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	10	10	10	10
Analyse	40	40	40	40
Evaluate	-	-	-	-
Create	-	-	-	-

Course Level Assessment Questions

1. Deduce the expression for viscous damping and criticize various damping system.

CO1: Analyse the single degree of freedom with free vibration.

2. Calculate the natural frequency of the system shown in fig1. The mass of the beam is negligible in comparison to the suspended mass. E =2x 10^5 N / mm^2 .
3. Deduce the expression for Logarithmic decrement and prove that δ = 2Πξ for damped free

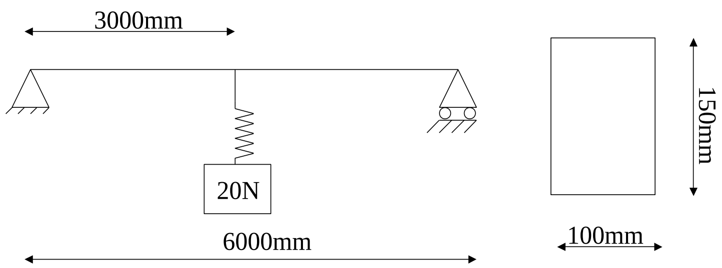


Fig 1

vibration.

4. A single degree of freedom system having a mass of 2.5 kg is set into motion with viscous damping and allowed to oscillate freely. The frequency of oscillation is found to be 20Hz and measurement of the amplitude of vibration shows two successive amplitudes to be 6mm and 5.5mm. Calculate the viscous damping coefficient.

1. An SDOF system consists of a mass of 20 kg, a spring of stiffness 2200N/m and a

CO2: Analyse the single degree of freedom forced vibration with harmonic excitation.

dashpot with a damping coefficient of 60N-s/m is subjected to harmonic excitation of F=200 sin 5t. write the complete solution of the equation of motion.

2. Deduce the expression for damped harmonic excitation.
3. Write a steady state response of undamped harmonic excitation with transient vibration

Calculate the natural frequency and amplitude ratio of the system for two degree of

CO3: Analyse the two degree of freedom with free vibration.

freedom system of your choice by using Lagrange's equation.

Deduce the expression response spectra for two degree of freedom undamped free vibration.

Calculate the natural frequencies and normal mode of this mode for a cantilever bar is to be modelled by a massless uniform bar to which are attached with two lumped masses representing the mass of original system as K=2AE/L and m=αAL.

1. Explain coordinate coupling of two degree of freedom system and derive amplitude

CO4: Analyse the two degree of freedom forced vibration with harmonic excitation.

ratio and frequencies.

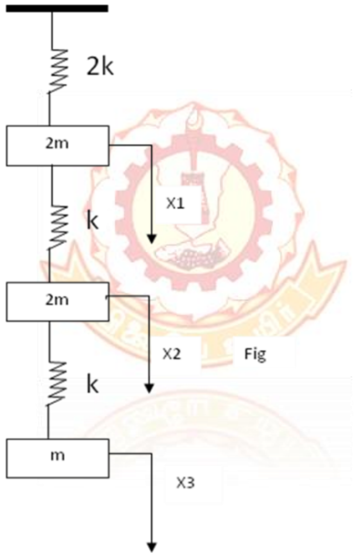
2. Examine measurement of damping using half-power bandwidth method.
3. Deduce the expression for damped forced vibration with harmonic excitation.

1. Deduce the expression for the response of Multi degree of freedom system for free

CO5: Analyse the Multi degree of freedom with free and forced vibration.

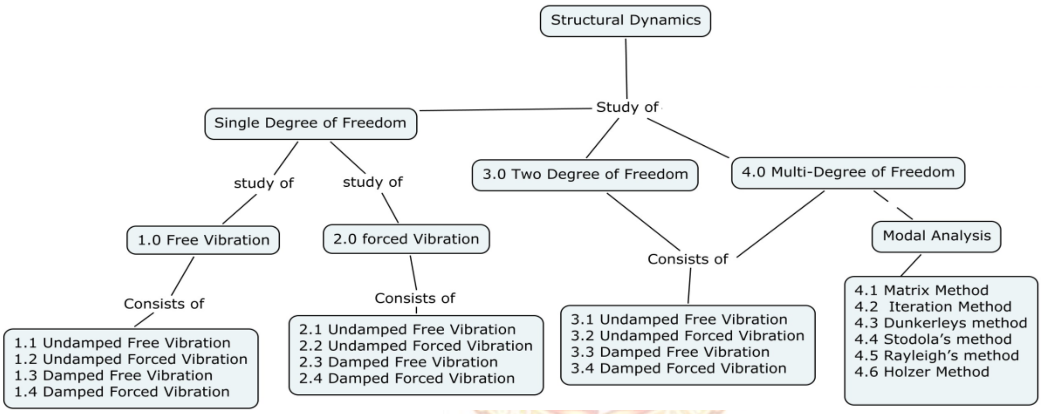
undamped vibration.

2. Deduce the expression for the response of Multi degree of freedom system for forced damped vibration.
3. Calculate the natural frequency and mode shape as shown in fig



4. Calculate the vertical deflection of cantilever beam is subjected to free end mass(m) using Rayleigh method. Using function of $x= 3y/L^3 (Lx^2/2 - x^3/6)$.
5. Investigate in detail Dunkerleys method and Stodola's method of modal analysis.
6. Calculate the lateral force with subjected to static and dynamic condensation.

Concept Map



Syllabus

Introduction to vibration and Damping: Simple Harmonic motion-Longitudinal Vibrations Equation of motion- SDOF analysis-Undamped SDOFs- dynamic equation of motion- D'Alemberts principle- equivalent stiffness-Springs connected in series and parallel- frequency and period Amplitude of motion- Energy method for the equation of motion- Damped SDOFs- underdamped and overdamped –Damped SDOFs- critically damped Logarithmic decrement ,method of determining damping. **Forced vibration of single degree of freedom system:** Undamped harmonic excitation. Damped harmonic excitation- Evaluation of damping at resonance-Response to support motion Torsional vibration- Dynamic Magnification Factor. **Two degrees of freedom for free vibration:** Principle modes of vibration and equation of motion for two degree of freedom-Two degrees of freedom for torsional system-Vibrations of undamped Two degrees of freedom. **Two degrees of freedom for forced vibration**: Forced Vibrations-Undamped forced vibration for two degrees of freedom –Orthogonality Principle. Eigen values and Eigenvectors(Natural frequencies and mode shapes) for two degree of freedom system. **Multi degree of freedom system:** Equation of motion of multi degree of freedom-Stiffness, mass and damping matrices. Influence Coefficient- problems-Modal co-ordinates. Introduction of modal analysis-Matrix Method –Rayleigh Method and Stodala's method-Natural frequencies and mode shapes-Modal analysis – damped undamped free vibration.

Reference Books

1. Anil K.Chopra, "Dynamics of Structures: Theory and Applications to Earthquake Engineering", Prentice Hall, Englewood Cliffs, New Jersy, Second Edition, 2001.
2. Berg. Glen v., "Elements of Structure Dynamics" 'Prentice Hall Englewood Cliffs, New Jersy.1989.

3. Cheng, F.Y., "Matrix Analysis of Structure Dynamics", Marcel Dekker, New York, 2001.
4. Clough, R.W.and Penzien,J., " Dynamics of Structure",McGraw-Hill,inc.,New York,1993.
5. Grover.G.K, "Mechanical vibrations, "New Chand and Bros., Roorkee.
6. Hurty.W.C, Rubinstein.M.F,"Dynamic of Structure", Prentice Hall of India Pvt Ltd.New Delhi.
7. Manicka Selvam K., "Elementary Structural Dynamics", Dhanpatrai and sons, New Delhi,2001.
8. Mario Paz, "Structural Dynamics: Theory and Computation", CBS Publications, New Delhi, 1994.
9. William Thomson, "Theory of Vibration and its applications", George Allen Pub.

Course Contents and Lecture Schedule

Module No.	Topics	No.of Lectures
1.	**Introduction to vibration and Damping**	
1.1	Free vibration of single degree of freedom systems, Simple Harmonic motion	1
1.2	Longitudinal Vibrations Equation of motion, SDOF analysis	1
1.3	Undamped SDOFs- dynamic equation of motion with electrical equivalent	1
1.4	Newtons law of motion, D'Alemberts principle- equivalent stiffness	1
1.5	Springs are connected in series and parallel, frequency and period, problems	1
1.6	Amplitude of motion, Energy method for the equation of motion	1
1.7	Damped SDOFs- underdamped, overdamped and critically damped	1
1.8	Logarithmic decrement ,method of determining damping	2
2.	**Forced Vibration of Single Degree of Freedom**	
2.1	Forced vibration of single degree of freedom system	1
2.2	Undamped harmonic excitation	1
2.3	Damped harmonic excitation with electrical equivalent	1
2.4	Response to support motion Torsional vibration and Dynamic Magnification Factor	2
2.5	Impulsive loading problems using Fourier series	2
2.6	Numerical evaluation of Duhamel's integral for damped system	1
3.	**Two Degree of Freedom (free vibrations)**	
3.1	Two degrees of freedom	1
3.2	Principle modes of vibration and equation of motion for two degree of freedom	1
3.3	Two degrees of freedom for torsional system	2
3.4	Vibrations of undamped Two degrees of freedom	2

4.	**Two Degree of Freedom (Forced vibrations)**	
4.1	Forced Vibrations and Undamped forced vibration for two degrees of freedom	1
4.2	Orthogonality principles	1
4.3	Eigen values and Eigen vectors	1
4.4	Calculation of Natural frequencies and mode shapes in two degree of freedom systems	2
5.	**Multi Degree of Freedom**	
5.1	Stiffness, mass, damping matrices and Influence Coefficient	1
5.2	Modal analysis – damped undamped free vibration	1
5.3	Matrix Method and Matrix Iteration Method	1
5.4	Stodola's method	2
5.5	Rayleigh's Method	1
5.6	Dynamic analysis method to evaluate lateral forces, Static and dynamic condensation	2
	Total Hours	**36**

Course Designers:

Dr.B.Sivagurunathan bsciv@tce.edu
Dr.D.Brindha dbciv@tce.edu

14CEPF0	PRESTRESSED CONCRETE	Category	L	T	P	Credit
		PE	2	2	0	3

Preamble

Prestressed concrete is used extensively in bridges, multistorey buildings and many other important parts of today's modern infrastructure. The inherent weakness of concrete in tension is offset by introducing a pre-compression in a prestressed member, which improves its service load behaviour such as reduced deflections and cracking. An advanced understanding of its behaviour is essential before safe and economical designs can be produced. This course will provide a detailed coverage of the behaviour of prestressed concrete, analysis and design for strength and serviceability of prestressed concrete members, such as beams and slabs including continuous members, and anchorage design and losses in prestress under IS codal provisions.

Prerequisites

Knowledge of Mathematics, Strength of Materials (14CE220) and Design of Reinforced Concrete Elements (14CE610)

Course Outcomes

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

			Expected Attainment level (%)	Expected Proficiency level (grade)
CO1	Describe the systems and methods of prestressing and suggest suitable method of prestressing for the given condition and its analysis	Apply	70	A
CO2	Determine the losses of prestress	Apply	70	A
CO3	Determine the deflection of prestressed concrete members	Apply	70	A
CO4	Analyse and design the prestressed concrete members under various forces	Apply	70	A
CO5	Analyse the prestressed concrete continuous members	Apply	70	A
CO6	Analyse and design the circular prestressed concrete members	Apply	70	A
CO7	Analyse the composite prestressed concrete members	Apply	70	A

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO59.	S	M	S	-	-	S	M	M	M	S	-	-	M	-
CO60.	S	M	S	-	-	S	M	M	M	S	-	-	M	-
CO61.	S	M	S	-	-	S	M	M	M	S	-	-	M	-
CO62.	S	M	S	-	-	S	M	M	M	S	-	-	M	-
CO63.	S	M	S	-	-	S	M	M	M	S	-	-	M	-
CO64.	S	M	S	-	-	S	M	M	M	S	-	-	M	-
CO65.	S	M	S	-	-	S	M	M	M	S	-	-	M	-

S- Strong; M-Medium; L-Low

Assessment Pattern:

Assessment	Test – I	Test – II	Test – III	End Semester
Remember	10	10	10	10
Understand	10	10	10	10
Apply	80	80	80	80
Analysis	--	--	--	--
Evaluate	--	--	--	--
Create	--	--	--	--
Total	100	100	100	100

Course Level Assessment Questions

CO1: Describe the systems and methods of prestressing and suggest suitable method of prestressing for the given condition and its analysis

10. What do you mean by prestressed concrete?
11. What are the reasons for using high tensile steel wires in prestressed concrete structures?
12. Differentiate between pretensioning and post tensioning systems.
13. Define the term: Tendon
14. Explain Fressinet system of post tensioning method with neat sketches
15. What do you mean by pressure and thrust line?
16. Explain load-balancing concept.

CO2: Determine the losses of prestress

1. Explain the losses of prestress in pretensioning and post tensioning system.
2. A prestressed concrete beam 250mm wide and 400mm deep is prestressed by 14 wires each of 7mm diameter initially stressed to 1300 N/mm^2 with their centroids located 120mm from the soffit. The span of the beam is 11m. Determine the percentage loss of stress in wires if (a) the beam is pretensioned and (b) the beam is post-tensioned using the following data: relaxation of steel stress = 5% of initial stress, Es=210 kN/mm^2, Ec=35 kN/mm^2, creep coefficient=1.6 and residual shrinkage strain = 3x10^{-4} for pretensioning and 2x10^{-4} for post-tensioning, slip at anchorage=1mm, Frictional coefficient for wave effect=0.0020 per m.

CO3: Determine the deflection of prestressed concrete members

1. What is the Lin's formula to find out long term deflection of prestressed concrete beam?
2. Explain Mohr's Theorem in deflection of prestressed concrete members.
3. What are the factors influencing the deflection of prestressed concrete members?
4. A prestressed concrete beam spanning over 10m is of rectangular section, 230mm wide and 500mm deep. The beam is prestressed by a parabolic cable having an eccentricity of 150mm below the centroidal axis at the centre of span and an eccentricity of 75mm above the centriodal axis at the support sections. The initial force in the cable is 450 kN. The beam supports an UDL of 15 kN/m. Ec = 38 kN/mm^2. Neglecting losses of prestress, calculate the short term deflection due to prestress and self weight; b) Allowing for 20 percent loss in prestress, calculate the long term deflection under prestress, self weight and live load, assuming the creep coefficient as 1.80.

CO4: Analyse and design the prestressed concrete members under various forces

5. What is the formula to find out the ultimate shear resistance of a section uncracked in flexure.
6. Give the maximum spacing of shear reinforcement in PSC beam as per IS code.
7. Give the ultimate shear resistance of a prestressed concrete section cracked in flexure.
8. Give the maximum spacing of shear reinforcement in PSC beam as per IS code.
9. Give the ultimate shear resistance of a prestressed concrete section cracked in flexure.
10. A pretensioned T-section is having flange width of 1300mm and thickness 125mm. the width and depth of rib is 230mm and 1500mm respectively. The area of high tensile steel is 5000mm^2 located at an effective depth of 1550mm. If the characteristic strength of concrete and steel are 40 N/mm^2 and 1600 N/mm^2, calculate the flexural strength of T-beam.
11. A pretensioned T-section is having overall depth of 1500mm and thickness of web is 200mm. The beam is subjected to an ultimate moment of 2000 kNm and shear force of 240 kN. The effective depth is 1250mm and cube strength of concrete is 50 N/mm^2. Effective prestress at the extreme tensile face of the beam is 20 N/mm^2. Area of steel Ap = 2400 mm^2. Tensile strength of tendons is 1600 N/mm^2. Effective stress in tendons after all losses is 900 N/mm^2. Calculate flexure resistance of the section using IS: 1343.
12. A prestressed concrete beam of rectangular section 150mm x 300mm is prestressed by a straight cable placed at an eccentricity 50mm below the neutral axis carrying an effective prestress of 180 Kn. The beam supports an udl of 18 Kn/m including self-weight. Determine shear resistance of uncracked section at supports and design the shear reinforcement. Take fck=40 Mpa and span=8m.
13. A prestressed concrete beam of rectangular section 150mm x 300mm is prestressed by a straight cable placed at an eccentricity 50mm below the neutral axis carrying an effective prestress of 180 kN. The beam supports an UDL of 18 kN/m including self-weight. Compute shear resistance of uncracked section at supports and design the shear reinforcement. Take fck = 40 Mpa, fy = 250 N/mm^2 and span = 8m.
14. Design a simply supported prestressed concrete slab for the following conditions. Span of the slab is 13m. Safe stress in concrete is 14N/mm^2. Safe stress in steel is 1200N/mm^2. Super imposed load is 23 kN/m^2.
15. A prestressed concrete beam 250mm wide and 600mm deep is subjected to a total prestressing force of 1500kN. This force is transmitted by two symmetrically arranged cables each transmitting a force of 750kN. Two anchor plates 200mm wide and 240mm deep are provided one for each cable. Design the reinforcement required in the transmission alone.

CO5: Analyse the prestressed concrete continuous members

1. State Mohr's second theorem
2. What is concordant cable profile?
3. Define the terms: Primary moment and secondary moment.

4. In two equal span prestressed concrete continuous beam ABC, the tendon has an eccentricity of 0.05m at support A and is bent sharply at a distance of 4m from A having an eccentricity of 0.12m in the span AB below the centre of the beam. And the tendon has an eccentricity of 0.15m at the support B above the centre of the beam. Then the tendon has a parabolic profile for the span BC having mid point eccentricity of 0.15m below the centre of the beam and zero at the support C. Locate the line of pressure (C-line) due to prestress alone. The prestressing force is 1200 kN. Calculate the extreme stresses in concrete at the section over the middle support. The size of the beam is 300mm x 600mm.

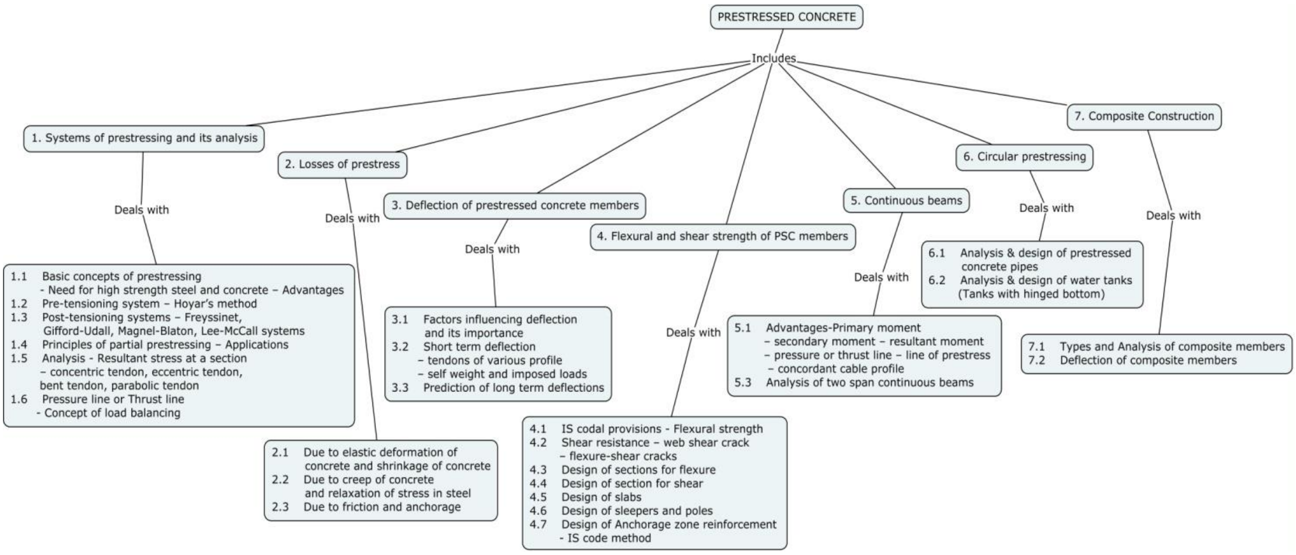
CO6: Analyse and design the circular prestressed concrete members

1. Draw the location of P-line and C-line in the prestressed concrete circular water tank.
2. Explain: Circular prestressing.
3. A prestressed concrete tank of diameter 10m has to resist an internal pressure head of 4m of water. Design the reinforcement required per metre height and the thickness of concrete required. Take Fc=Ultimate strength of concrete = 40 N/mm^2, fc=safe stress in concrete=0.5Fc at transfer, fs=1300 N/mm^2, loss of prestress=20%, m=8.0
4. Design a non-cylinder prestressed pipe of 600mm diameter to withstand a working pressure of 1 N/mm^2 and calculate the test pressure required to produce a tensile stress of 0.7 N/mm^2 in the concrete when applied immediately after tensioning. F_{et}=14 N/mm^2 and k=0.80.
5. Design a cylindrical prestressed water tank of internal diameter 32m and height 8m. Compressive stress in concrete is not to exceed 12.5 N/mm^2 at transfer. Minimum compressive stress at working loads is to be 1 N/mm^2. The prestress is to be provided by a circumferential winding of 6m diameter wire and vertical cables of 12, 5mm dia wires in which the stress at transfer is 900 N/mm^2 and k=0.75.

CO7: Analyse the composite prestressed concrete members

1. What do you mean by unpropped method of composite construction?
2. Explain the principles of erection of precast structural member.
3. What are the advantages of having prestressed concrete structures in composite construction?
4. Explain the analysis of stresses in composite construction with neat sketches.
5. Calculate the resultant stress developed in the precast and insitu cast concrete when the beam is propped during the casting of slab. The size of the beam is 150mm x 300mm. Assume the same modulus of elasticity for concrete in precast beam and insitu cast slab. The beam with an effective span of 4.5m is prestressed by tendons with their centroids coinciding with the bottom kern. The initial force in the tendons is 150 kN. The loss of prestress may be assumed to be 18%. The beam is incorporated in a composite T-beam by casting a top flange of breadth 450mm and thickness 50mm. The composite beam supports a live load of 4.5 kN/m^2.

Concept Map



Syllabus

Systems of prestressing and its analysis - Basic concepts of prestressing - Need for high strength steel and concrete – Advantages - Pre-tensioning system – Post-tensioning systems - Principles of partial prestressing – Applications - Analysis of prestress and bending stresses **-** Resultant stress at a section – concentric tendon, eccentric tendon, bent tendon, parabolic tendon - Pressure line or Thrust line - Concept of load balancing – Cracking moment. **Losses of prestress –** loss due to elastic deformation of concrete - shrinkage of concrete - creep of concrete - relaxation of stress in steel - friction – anchorage. **Deflection of prestressed concrete members -** Factors influencing deflection and its importance - Short term deflection – tendons of various profile – self weight and imposed loads - Prediction of long term deflections. **Flexural and shear strength of PSC members -** IS codal provisions - Flexural strength –Shear resistance – web shear crack – flexure-shear cracks - Design of sections for flexure – Shear - Design of slabs - Design of sleepers and Poles **-** Design of Anchorage zone – IS method. **Continuous beams –** Advantages - Primary moment – secondary moment – resultant moment – pressure or thrust line – line of prestress – concordant cable profile - Analysis of two span continuous beams. **Circular prestressing -** Analysis & design of prestressed concrete pipes - Analysis & design of water tanks (Tanks with hinged bottom). **Composite Construction -** Types and Analysis of composite members - Deflection of composite members – PT slab-site inspection.

Text Books

3. N. Krishna Raju, Prestressed Concrete, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2012
4. N. Rajagopalan, Prestressed Concrete, Alpha Science International Ltd, New Delhi, 2005

Reference Books

1. T.Y. Lin, & Ned. H. Burns, Design of Prestressed Concrete Structures, John Wiley & Sons, New York, 2010.
2. Arthur H.Nilson, Design of Prestressed Concrete, John Wiley & Sons, New York, 2007.
3. P. Dayaratnam, Prestressed Concrete Structures, Oxford and IBH, New Delhi, 2003.
4. M.C. Sinha & S.K. Roy, Fundamentals of Prestressed Concrete, S.Chand & Company Ltd, New Delhi, 2013.

5. Ramaswamy G.S., Modern pre-stressed concrete design, Arnold Heinimen, New Delhi, 2005.
6. Self learning materials – NPTEL - http://www.nptel.ac.in/courses/105106117/

IS Codes

7. IS 1343:1980 Code of Practice for Pre Stressed Concrete
8. IS 3370 (Part 3):1965 Code of Practice for Concrete Structures for the Storage of Liquids-Part 3 Pre stressed Concrete
9. IS 3370 (Part 4):1965 Code of Practice for Concrete Structures for the Storage –Part-4 Design Tables
10. IS 784:2001 Prestressed concrete pipes (including specials) - Specification.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.	**Systems of prestressing and its analysis**	
1.1	Basic concepts of prestressing - Need for high strength steel and concrete – Advantages	1
1.2	Pre-tensioning system – Hoyar's method	1
1.3	Post-tensioning systems – Freyssinet, Gifford-Udall, Magnel-Blaton, Lee-McCall systems	1
1.4	Principles of partial prestressing – Applications	1
1.5	Resultant stress at a section – concentric tendon, eccentric tendon, bent tendon, parabolic tendon, Pressure line or Thrust line - Concept of load balancing	1
	Tutorial – Problems on analysis of prestress	4
2.	**Losses of prestress**	
2.1	Due to elastic deformation of concrete and shrinkage of concrete	1
2.2	Due to creep of concrete and relaxation of stress in steel	1
2.3	Due to friction and anchorage	1
	Tutorial – Problems on losses of prestress	4
3.	**Deflection of prestressed concrete members**	
3.1	Factors influencing deflection and its importance	1
3.2	Short term deflection – tendons of various profile – self weight and imposed loads	1
3.3	Prediction of long term deflections	1
	Tutorial – Problems on deflection calculations	2
4.	**Flexural and shear strength of PSC members**	
4.1	IS codal provisions - Flexural strength	1
4.2	Shear resistance – web shear crack – flexure-shear cracks	1
4.3	Design of sections for flexure	1
4.4	Design of section for shear	1
4.5	Design of slabs	1

4.6	Design of sleepers and poles	1
4.7	Design of Anchorage zone reinforcement - IS code method	1
	Tutorial – Problems on design of prestressed concrete members	4
5.	**Continuous beams**	
5.1	Advantages - Primary moment – secondary moment – resultant moment – pressure or thrust line – line of prestress – concordant cable profile	1
5.2	Analysis of two span continuous beams	1
	Tutorial – Problems on continuous members	4
6.	**Circular prestressing**	
6.1	Analysis & design of prestressed concrete pipes	1
	Tutorial – Problems on design of pipes	2
6.2	Analysis & design of water tanks (Tanks with hinged bottom)	1
	Tutorial – Problems on design of tanks	2
7.	**Composite Construction**	
7.1	Types and Analysis of composite members	1
7.2	Deflection of composite members	1
	Tutorial – Problems on composite members	2
	Total (Theory = 24; Tutorial = 24)	**48**

Course Designers

Dr. K. Arunachalam karcivil@tce.edu
Dr. K. Sudalaimani ksudalaimani@tce.edu
Dr. M.C. Sundarraja mcsciv@tce.edu

14CEPG0	REPAIR AND REHABILITATION OF STRUCTURES	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

To impart knowledge on understanding the properties of concrete, causes of its failure, effects and measures to repair and rehabilitate it.

Course Outcomes

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

		Expected Attainment level (%)	Expected Proficienc level (grad
(CO1) **Explain the factors affecting the durability of concrete structures**	**Understand**	**70**	**A**
(CO2) **Identify the causes and effects of distress in concrete structures**	**Understand**	**70**	**A**
(CO3) Diagnose distress in concrete structures and suggest suitable maintenance and repair strategies	**Apply**	**70**	**A**
(CO4) Enumerate the concept of quality assurance in structures, basic mechanisms by which quality assurance schemes are developed and operated with case studies	**Apply**	**70**	**A**
(CO5) Suggest suitable materials of repair related to the distress with case studies	**Apply**	**70**	**A**
(CO6) Suggest suitable techniques of repair to distress strcutures with case studies	**Apply**	**70**	**A**

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO7.	-	L	-	L	-	-	-	-	-	-	M	-	-	L
CO8.	M	M	L	M	-	L	-	-	-	-	M	-	-	M
CO3	L	M	M	M	-	M	L	-	L	-	S	-	L	S
CO4	M	M	M	M	-	S	L	L	-	-	S	-	L	S
CO5	L	M	M	M	-	S	M	L	M	M	M	-	M	M
CO6	L	M	M	M	-	S	M	L	M	M	M	-	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	60	40	40	40
Apply	20	40	40	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Discuss the phenomenon of sulphate attack on concrete mentioning the methods to minimize the same
2. Differentiate between the terms Repair, Rehabilitation and Retrofitting
3. Define the term permeability. List the factors affecting permeability of concrete

(CO2):

1. Discuss the mechanism of corrosion in rebars and discuss the influencing factors
2. Mention if cover thickness is related to corrosion of rebars? if so how?
3. List the types of distress that are likely to affect a break water structure discussing the causes and effects

(CO3):

1. Name two NDT tests of assessing quality of concrete
2. By means of a flow chart discuss the method of diagnosing distress in concrete structures
3. Which special concrete you would recommend for a concrete structure to be constructed in freezing climatic conditions and why? Also discuss the properties of such a concrete

(CO4):

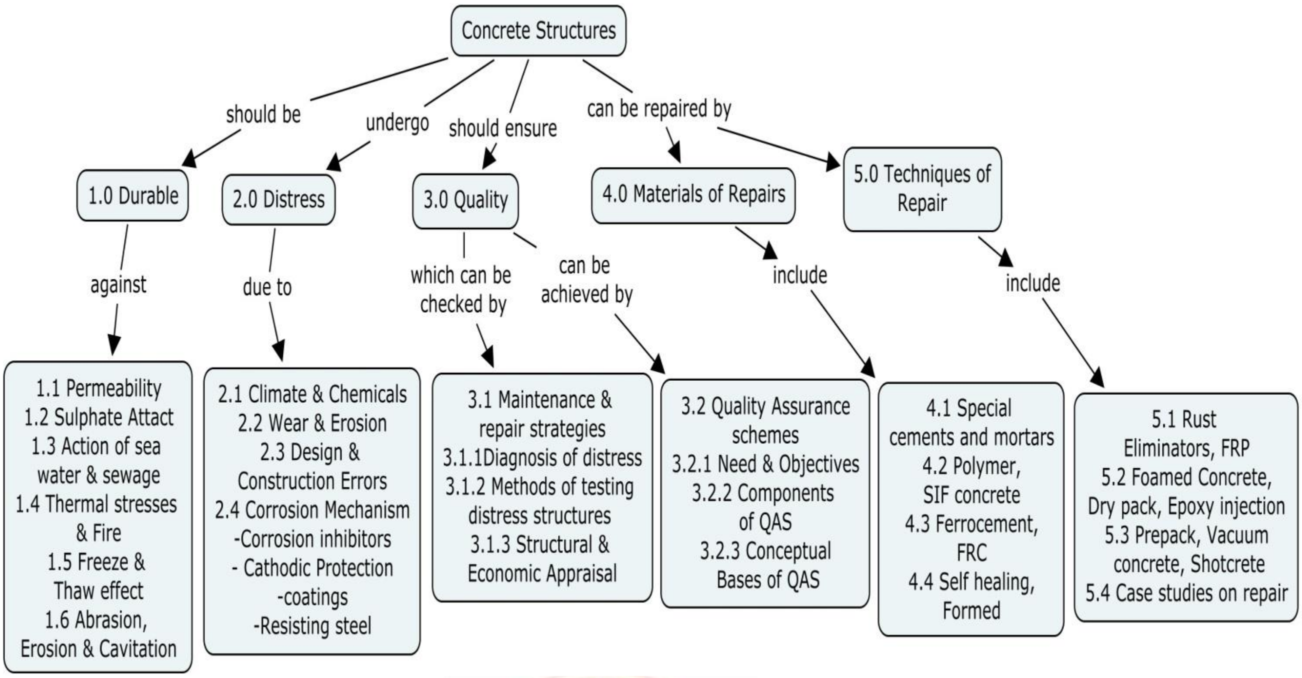
1. Discuss the various methods of corrosion protection of rebars
2. Define the term quality assurance and mention its need
3. As a quality assurance engineer identify and discuss the components you would include in devising a new quality assurance scheme for a new organization.

(CO5):

1. How do you make concrete buried under polluted ground resistant to corrosion? Discuss the various methods

2. Discuss a method of strengthening of a concrete beam. Discuss the properties of the materials used in the strengthening method
3. Which is the special concrete you would recommend for a concrete water tank and why? Give suitable reasoning discussing its features
4. What is the concreting technique you would recommend for a marine bridge pier construction? Justify and discuss its salient features

Concept Map



Syllabus

Durability of Concrete Structures - Permeability of concrete- Sulphate attack – methods of control – durability of concrete in sea water- action of sewage – thermal properties of concrete – fire resistance – resistance to freezing and thawing – resistance to abrasion, erosion and cavitation. **Distress in concrete structures- causes, effects and remedial measures**- effects due to climate, temperature, chemicals, wear and erosion, design and construction errors, corrosion mechanism, effects of cover thickness and cracking, methods of corrosion protection, inhibitors, resistant steels, coatings, cathodic protection. **Maintenance and Repair Strategies -** Inspection, structural appraisal, economic appraisal- Diagnosis of distress – Procedure. **Quality assurance** – need- components- conceptual bases of quality assurance schemes. **Materials for Repair –** Special concretes and mortars, special cements for accelerated strength gain, expansive cement, polymer concrete, sulphur infiltrated concrete, ferro-cement, fibre reinforced concrete, self healing concrete, formed concrete, Fibre reinforced Polymers. **Techniques of Repair –** Rust eliminators and polymer coating for rebars during repair, foamed concrete, mortar and dry pack, prepack, vacuum concrete, gunite and shotcrete, epoxy injection, mortar repair for cracks – case studies on distress concrete structures and type of treatment done.

Text Book

1. Dension Campbell, Allen and, Harold Roper, " Concrete Structures, Materials, Maintenance and Repair", Longman Scientific and Technical Publications UK, 1991

Reference Books

1. Shetty. M.S., "Concrete Technology – Theory and Practice", S.Chand Company, New Delhi, 2010
2. Gambhir. M.L. " Concrete Technology", Tata McGraw Hill Publishing Co., New Delhi, 1998.
3. ACCE(I), Madurai Centre, "Workshop on cracks, corrosion and leaks", July 2003
4. Allen R.T. and Edwards. S.C., "Repairs of Concrete Structures", Blakie and Sons, UK, 1997.
5. Raikar R.N., " Learning from failures", Structwel Designers & Consultants, New Delhi, 1987.
6. Lecture notes on "Workshop on Repairs & Rehabilitation of Structures", Organized by Dept. of Civil Engg., Anna University, Chennai 29-30 October, 1999

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.	**Durability of Concrete Structures**	
1.1	Permeability of concrete- factors influencing, methods of improving impermeable characteristics	1
1.2	Sulphate attack – influencing factors & methods of control	1
1.3	Durability of concrete in sea water- action of sewage – influencing factors	1
1.4	Thermal properties of concrete – fire resistance - factors influencing	1
1.5	Resistance to freezing and thawing- influencing factors	1
1.6	Resistance to abrasion, erosion and cavitation – influencing factors	1
2.	**Distress in concrete structures- causes, effects and remedial measures**	
2.1	Effects due to climate, temperature, chemicals - causes, effects and remedial measure	1
2.2	Wear and erosion- causes, effects and remedial measure	1
2.3	Design and construction errors –causes, effects and remedial measure	2
2.4	Corrosion mechanism, types of corrosion, effects of cover thickness and cracking- influencing factors. Methods of corrosion protection, inhibitors, resistant steels, coatings, cathodic protection	2
3.0	**Quality of Concrete Structures**	
3.1	**Maintenance and Repair Strategies**	
3.1.1	Inspection, types of maintenance, structural appraisal, economic appraisal Diagnosis of distress – Procedure	1
3.1.2	Methods of assessing the quality of concrete – NDT and DT tests	1
3.1.3	Structural Appraisal & Economic Appraisal	1

3.2	**Quality assurance**	
3.2.1	Need and Objectives- people benefited by QAS	1
3.2.2	Components, Conceptual bases of quality assurance schemes	2
3.2.3	Basic methods of development and operation of QAS	2
4.	**Materials for Repair**	
4.1	Special concretes and mortars, special cements for accelerated strength gain, expansive cement – properties, methods of manufacture and applications	2
4.2	Polymer concrete, sulphur infiltrated concrete- properties, methods of manufacture and applications	2
4.3	Ferro-cement, fibre reinforced concrete- properties, methods of manufacture and applications	2
4.4	Self healing concrete, formed concrete, Fibre reinforced Polymers - properties, methods of manufacture and applications	2
5.	**Techniques of Repair**	
5.1	Rust eliminators and polymer coating for rebars during repair	2
5.2	Foamed concrete, mortar and dry pack, epoxy injection, mortar repair for cracks	2
5.3	Prepack, vacuum concrete, gunite and shotcrete – procedure and applications	2
5.4	Case studies on distress concrete structures and type of treatment done Forensic investigations – case studies	2
	Total Periods	**36**

Course Designers:

G.Chitra gcciv@tce.edu

	Category	L	T	P	Credit
14CEPH0 GROUND IMPROVEMENT TECHNIQUES	PE	3	0	0	3

Preamble

This course deals with the different ground improvement methods adopted for improving the properties of remoulded and in-situ soils by adopting different techniques such as in- situ densification, consolidation and dewatering methods. This course enables the students to understand how reinforced earth walls can obviate the problems associated with conventional retaining walls. Also the students would be exposed to the concepts of grouting, soil stabilization and the use of geotextiles to improve the engineering performance of soils.

Prerequisite

Fundamentals of Mathematics, Soil Mechanics (14CE530) and Foundation Engineering (14CE630), knowledge of geology and earth science.

Course Outcomes

On the successful completion of the course, students will be able to:			Expected Attainment Level (%)	Expected Proficiency Level (grade)
CO1	Enumerate the role of ground improvement and select appropriate ground improvement technique for the given subsoil condition.	Apply	70	A
CO2	Suggest appropriate dewatering technique for lowering the ground water table	Apply	70	A
CO3	Recommend suitable techniques for densifyingcohesionless soil deposit	Apply	70	A
CO4	Suggest appropriate techniques for consolidating cohesive deposits	Apply	70	A 80
CO5	Perform simple design of reinforced earth walls and illustrate the role of geo-textile in ground improvement.	Apply	70	A
CO6	Explain the concept of grouting and soil stabilization to improve the engineering performance of soils.	Understand	70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO9.	S	M	L	-	-	L	-	L	-	-	M	L	M	M
CO10.	S	M	L	-	L	M	-	L	-	-	M	L	M	L
CO3.	S	M	M	-	L	M	-	L	-	-	M	L	M	M
CO4.	S	M	M	-	L	-	-	L	-	-	M	L	L	L
CO5.	S	M	M	-	L	-	-	M	-	-	M	L	M	L
CO6.	M	L	L	-	-	-	-	M	-	-	M	L	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	40	20	20	20
Understand	60	60	60	60
Apply	---	20	20	20
Analyse	---	---	---	---
Evaluate	---	---	---	---
Create	---	---	---	---

Course Level Assessment Questions

Course Outcome 1 (CO1):

4. Explain in detail the role of ground improvement in foundation engineering.
5. Define challenging soil.
6. Explain in brief the various methods of ground improvement.
7. Name the various soil deposits found in India.

Course Outcome 2 (CO2):

1. Define dewatering.
2. Explain in detail with a neat sketch the method of dewatering using sumps and ditches stating its advantages and disadvantages.
3. Explain in brief the principle, equipment used, installation and operation and precaution adopted in electro-osmotic dewatering.
4. Compare the various dewatering systems suitability, uses, merits and demerits.

Course Outcome 3 (CO3):

1. Differentiate vibro-displacement from vibro-replacement stone columns.
2. Compare and contrast the various methods of in-situ densification techniques
3. Differentiate lime pile from sand compaction pile.
4. Explain in detail the method of dynamic compaction of cohesion less and dynamic consolidation of cohesive soil.
5. Explain in detail about the method of pre-loading. How do vertical drains improve the functioning of pre-loading technique.

Course Outcome 4 (CO4):

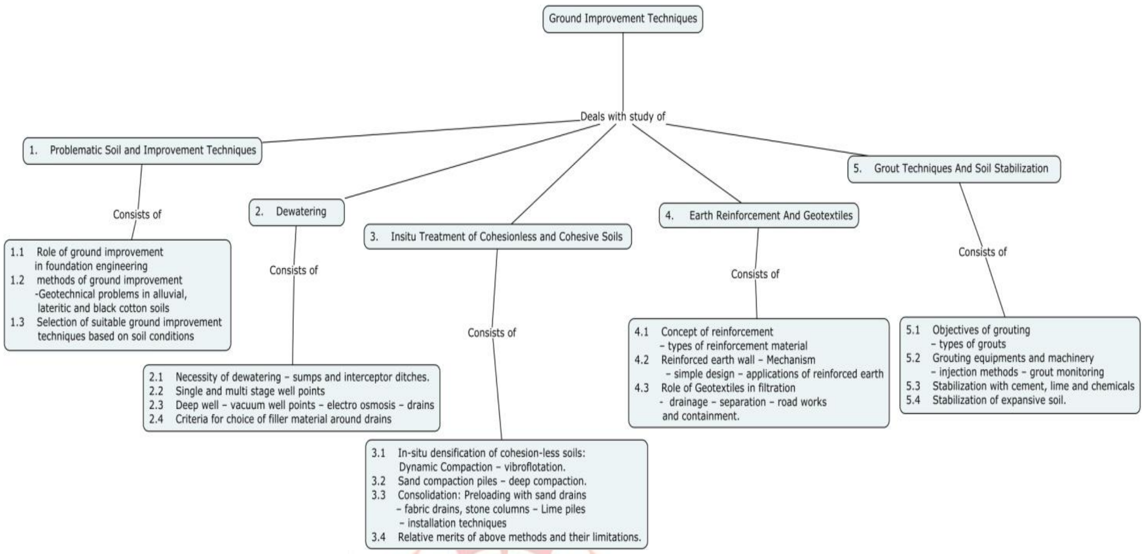
3. Name any four applications of soil reinforcement for ground improvement.
4. Define geosynthetics.
5. Explain with the help of a flow chart the various classifications of geosynthetics in detail.
6. Geosynthetics can be used as soil reinforcement – Jusify in detail with supporting sketches.

Course Outcome 5 (CO5):

1. Describe in detail about the various methods of grouting with neat sketches.
2. Enumerate with a neat sketch the grouting plant and equipment necessary and the procedure for carrying out grouting operations.

3. Describe in detail the various applications of grouting.
4. Explain in detail how an expansive soil is stabilized.

Concept Map



Syllabus

Problematic Soil and Improvement Techniques: Role of ground improvement in foundation engineering – methods of ground improvement – Geotechnical problems in alluvial, lateritic and black cotton soils – Selection of suitable ground improvement techniques based on soil conditions. **Dewatering:** Necessity of dewatering – sumps and interceptor ditches – single and multi stage well points – deep well - vacuum well points – electro osmosis – drains – criteria for choice of filler material around drains. **Insitu Treatment of Cohesionless and Cohesive Soils:** In-situ densification of cohesion-less soils: Dynamic Compaction - vibroflotation, sand compaction piles - deep compaction. Consolidation: Preloading with sand drains - fabric drains, stone columns - Lime piles - installation techniques – relative merits of above methods and their limitations. **Earth Reinforcement And Geotextiles:** Concept of reinforcement – types of reinforcement material – Reinforced earth wall – Mechanism – simple design – applications of reinforced earth - Role of Geotextiles in filtration - drainage - separation - road works and containment. **Grout Techniques and Soil Stabilization:** Objectives of grouting - types of grouts – grouting equipments and machinery – injection methods – grout monitoring – stabilization with cement, lime and chemicals – stabilization of expansive soil.

Text Books

1. Purushothama Raj. P, "Ground Improvement Techniques", Laxmi Publications (P) Ltd, New delhi, 2007.
2. Koerner, R.M. "Construction and Geotechnical Methods in Foundation Engineering", McGraw Hill, 1994.
3. Mittal.S, "An Introduction to Ground Improvement Engineering", Medtech Publisher, 2013.

Reference

1. Moseley, M.P., “Ground Improvement”, Blackie Academic and Professional, Chapman and Hall, Glasgow, 1998.
2. Jones J.E.P. “Earth Reinforcement and Soil Structure”, Butterworths, London, 1985.
3. Coduto, D.P. “Geotechnical Engineering – Principles and Practices”, Prentice Hall of India Pvt.Ltd. New Delhi, 2011.
4. Koerner, R.M. “Designing with Geosynthetics” 4th Edition,Prentice Hall, Jersey, 1999.
5. IS9759 : 1981 “Guidelines for Dewatering During Construction”, Bureau of Indian Standards, New Delhi, Reaffirmed 1999.
6. IS15284 (Part 1) : 2003 “Design and Construction for Ground Improvement – Guidelines” (Stone Column), Bureau of Indian Standards, New Delhi, 2003.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.	**Problematic Soil and Improvement Techniques**	
1.1	Role of ground improvement in foundation engineering	2
1.2	methods of ground improvement – Geotechnical problems in alluvial, lateritic and black cotton soils	2
1.3	Selection of suitable ground improvement techniques based on soil conditions	2
2.	**Dewatering**	
2.1	Necessity of dewatering – sumps and interceptor ditches.	1
2.2	Single and multi stage well points	2
2.3	Deep well – vacuum well points – electro osmosis – drains	2
2.4	Criteria for choice of filler material around drains	2
3.	**Insitu Treatment of Cohesionless and Cohesive Soils**	
3.1	In-situ densification of cohesion-less soils: Dynamic Compaction – vibroflotation.	2
3.2	Sand compaction piles – deep compaction.	2
3.3	Consolidation: Preloading with sand drains – fabric drains, stone columns – Lime piles – installation techniques	2
3.4	Relative merits of above methods and their limitations.	2
4.	**Earth Reinforcement And Geotextiles**	
4.1	Concept of reinforcement – types of reinforcement material	2
4.2	Reinforced earth wall – Mechanism – simple design – applications of reinforced earth	2

4.3	Role of Geotextiles in filtration - drainage– separation – road works and containment.	2
5.	**Grout Techniques And Soil Stabilization**	
5.1	Objectives of grouting – types of grouts	2
5.2	Grouting equipments and machinery – injection methods – grout monitoring	2
5.3	Stabilization with cement, lime and chemicals	2
5.4	Stabilization of expansive soil.	2
	Total (Hours)	**36**

Course Designers

Mr. R. Sanjay kumar sanjaykumar@tce.edu

Mr. R.Sankaranarayanan rsciv@tce.edu

14CEPJ0 **TRAFFIC ENGINEERING AND SAFETY**

Category	L	T	P	Credit
PE	3	0	0	3

Preamble

Students will acquire comprehensive knowledge of traffic surveys and studies such as volume count, Speed and delay, origin and destination, Parking, pedestrian and accident surveys. They will achieve knowledge on design of at- grade and grade separated intersections. Students will become familiar with various traffic control and traffic management measures.

Prerequisite

Nil

Course Outcomes

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

		Expected Attainment level (%)	Expected Proficiency level(grade)
CO1: Explain road user and vehicular characteristics	Understand	75	A
CO2: Bring out speed and volume studies and their relationships	Understand	75	A
CO3: Design geometrics of intersections,	Apply	75	A
CO4: Enumerate the various road safety requirements	Understand	75	A
CO5: Design the signal phasing and design a rotary	Apply	75	A
CO6: Identify various traffic control measures	Apply	75	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO11.	S	M	L	L	-	-	-	-	-	-	-	-	M	-
CO12.	S	L	-	-	-	-	-	-	-	-	-	-	L	-
CO3.	S	S	S	S	-	-	-	L	-	-	-	-	M	-
CO4.	L	L	L	L	-	-	-	-	-	-	-	-	L	-
CO5.	S	S	M	-	-	-	-	L	-	-	-	-	M	-
CO6.	S	-	-	-	-	-	-	-	-	-	-	-	L	-

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	40	40	40	40
Apply	40	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

11. List the various human factors which are of importance to driver.
12. List out the different types of resistance offered by the vehicle while it is in motion.
13. Mention the various driver characteristics affecting traffic behaviour on roads

Course Outcome 2 (CO2):

1. Explain the significance and scope of traffic engineering.
2. Describe the different methods of conducting Speed and Delay studies.
3. Mention the principle and application of Traffic Volume Studies.

Course Outcome 3 (CO3):

1. The following data were obtained from the spot speed studies.

   Suggest i) Speed limit for regulation ii) Speed to check geometric design elements

   iii) Lower speed group causing congestion iv) Dispersion.

Speed range kmph	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
No. of vehicles observed	20	45	75	95	290	420	210	155	85	40

2. Traffic flow in an urban section at the intersection of two highways in the design year is given below. The highways intersect at right angles and have a carriage way width of 16m.Design the rotary intersection using PCU value of car =1, commercial vehicle (com.v) =2.8 and scooter (SC)=0.75.

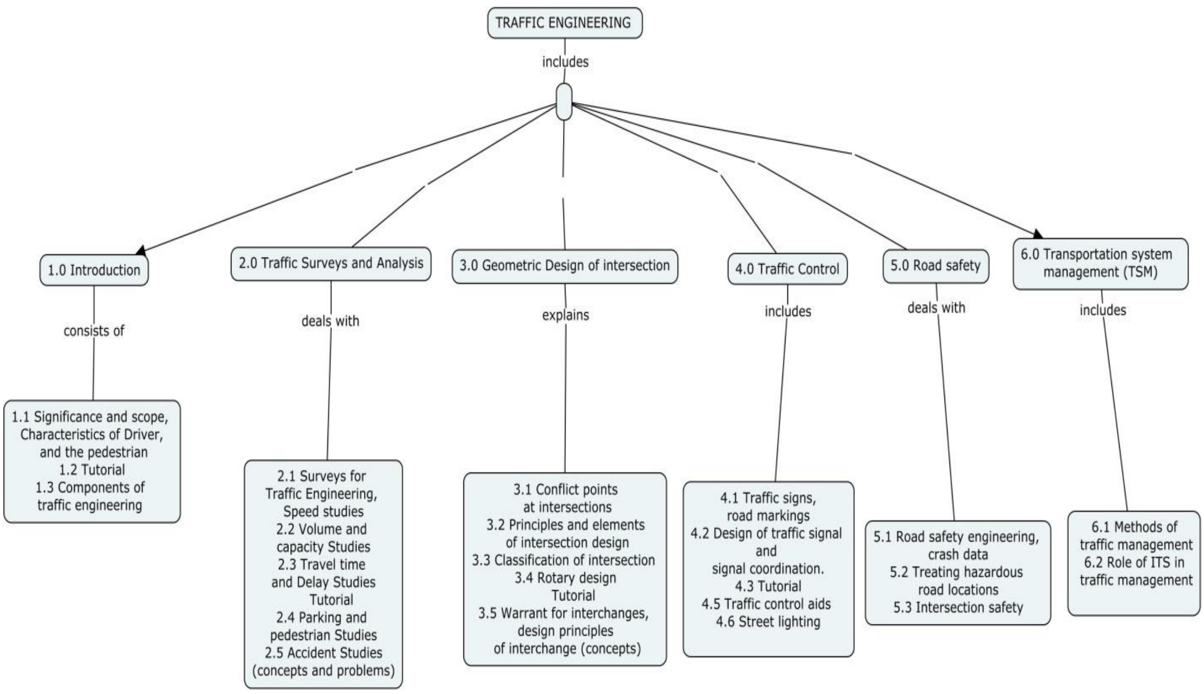
Approach	Left turning			Straight Ahead			Right Turning		
	Car	Com.V	SC	Car	Com.V	SC	Car	Com.V	SC
N	200	50	100	250	40	160	150	50	80
E	175	60	80	210	60	120	150	60	120
S	245	70	100	120	50	80	160	55	80
W	210	40	120	190	45	100	180	75	100

3. Draw neatly a rotary intersection where four roads meet and indicate the directions of traffic flow.

Course Outcome 4 (CO4):

1. **Mention the classification of road signs.**
2. **State the objectives in providing road markings and describe its effectiveness in traffic regulation.**
3. **List the benefits of providing street furnitures.**
4. **Explain roadside hazard management with suitable illustrations.**
5. **Recall various methods of traffic control in urban roads.**

Concept Map



Syllabus

Introduction. Significance and scope, Characteristics of Driver, the pedestrian, the vehicle and road, skid resistance and braking efficiency. Components of traffic engineering – road, traffic and land use characteristics. **Traffic Surveys and Analysis -**volume, capacity speed and delay studies, origin and destination, parking studies, pedestrian and Accident studies. **Geometric Design of intersection-** conflict points at intersections, principles and elements of intersection design, rotary design, Interchanges – Warrant for interchanges, design principles of interchange –level of service.**Traffic Control-** Traffic signs, road markings, design of traffic signal and signal coordination. Traffic Control aids **-** street furnitures, street lighting **Road safety-** Road safety engineering, importance of good crash data, treating hazardous road locations (blackspots), intersection safety, delineation of rural roads, roadside hazard management, road safety at road works, Traffic management plan (TMP. **Traffic management systems -** methods and techniques for traffic management **-** role of ITS in traffic management.

Text Book

Kadiyali L.R, “Traffic Engineering and Transportation Planning” Khanna Publishers, Delhi, 2005.

Reference Books

1. Khanna SK and Justo CEG, “Highway Engineering”, Nem Chand & Bros, Roorkee, 2010.
2. Brase/Brase “Understandable Statistics 3rd edition”,D C Health and Company, Lexington, Massachusetts,Toronko,1987.
3. Jason C.yu, Transportation Engineering: Introduction to Planning, Design and Operations, Elsevier,1992.
4. Taylor M.A.P and Young W,Traffic Analysis-New Technology and New solutions, Hargreen Publishing Company,1998.
5. Nicholas J. Garben and Lester A Hoel,”Traffic and Highway Engineering”, PWS Publication,1999.
6. Partha Chakroborty and Animesh Das,” Principle of Traffic Engineering”,Prentice Hall of India,New Delhi,2003.
7. Flaherty,”Transportation Planning and Traffic Engineering”, Elesevier India Pvt Ltd.,2006.
8. Mike Slinn, Peter Guest and Paul Matthews “Traffic Engineering Design Principles and Practice”,Elesevier, 2006.
9. http://www.nptel.ac.in/downloads/105101008/

Course Contents and Lecture Schedule

Module No.	Topic	No.of Lectures
1.0	**Introduction**	
1.1	Significance and scope, Characteristics of Driver, the pedestrian, the vehicle and road, skid resistance and braking efficiency	2
1.3	Components of traffic engineering – road, traffic and land use characteristics	2
2.0	**Traffic Surveys and Analysis**	
2.1	Surveys for Traffic Engineering, Speed studies	2
2.2	Volume and capacity Studies	1
2.3	Travel time and Delay Studies	1
2.4	Parking and pedestrian Studies	1
2.5	Accident Studies(concepts and problems)	1
3.0	**Geometric Design of intersection**	
3.1	Conflict points at intersections	1
3.2	Principles and elements of intersection design	2
3.3	Classification of intersection – concepts of flow in at grade and grade separated intersections	1
3.4	Rotary design	2
3.5	Warrant for interchanges, design principles of interchange – capacity analysis level of service (concepts)	2
4.0	**Traffic Control**	
4.1	Traffic signs, road markings – significance, classification and purpose	2
4.2	Design of traffic signal and signal coordination.	2
4.4	Design for parking facilities, (concepts and problems).	2
4.5	Traffic control aids -Types of street furnitures	2
4.6	Street lighting – Purpose, importance	1
5.0	**Road safety**	
5.1	Road safety engineering, crash data	2
5.2	Treating hazardous road locations	1
5.3	Intersection safety, delineation of rural roads, roadside hazard management, road safety at road works	2
6.0	**Traffic Management**	
6.1	Methods of traffic management	2
6.2	Role of ITS in traffic management	2
	TOTAL HOURS	**36**

Course Designers:

1. Dr. R. Velkennedy rvkciv@tce.edu
2. Ms. D. Srividya dsciv@tce.edu

14CEPK0 ENVIRONMENTAL IMPACT ASSESSMENT

Category	L	T	P	Credit
PE	3	0	0	3

Preamble

To impart the knowledge on the preparation of Environmental Management Plan and

to expose the students to the need, methodology, documentation and preparation of Environmental Impact Assessment report .

Prerequisite

Nil

Course Outcomes

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

			Expected Attainment Level (%)	Expected Proficiency Level(grade)
CO1.	To understand the EIA process as it is used for planning, project evaluation and regulatory enforcement	Understand	70	A
CO2.	Assess the impacts and risks that will be caused by projects or industries and the methods to overcome these impacts	Apply	70	A
CO3.	Adopt the methods and tools to predict the impact on Environment .	Apply	70	A
CO4.	Prepare terms of reference for environmental impact and socio-economic impact for any developmental project	Apply	70	A
CO5.	Prepare environmental management plan by considering environmental aspects and impacts	Apply	70	A
CO6.	Prepare Risk Mitigation plan by assessing the potential hazards for any project	Apply	70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	-	-	-	-	M	M	-	-	-	-	-	L	L
CO2	S	S	M	M	-	M	S	-	-	-	-	-	M	L
CO3	L	L	M	M	-	L	S	-	-	-	-	-	M	L
CO4	M	M	L	M	-	M	S	M	S	S	-	-	L	M
CO5	S	S	S	S	-	S	S	M	S	S	-	M	M	M

CO6	S	S	S	S	-	S	S	M	S	S	-	M	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	**20**	**20**	**20**	**20**
Understand	**40**	**40**	**40**	**40**
Apply	**40**	**40**	**40**	**40**
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Discuss the role of Public Participation in Environmental Decision Making.
2. EIA is an effective management tool : comment
3. Explain the various methodologies adapted for prediction of impacts for EIA report

Course Outcome 2 (CO2):

1. Explain the legal framework for getting environment clearance for new projects.
2. Describe the procedure for conducting the public hearing as per EIA notification 2006.
3. Explain the legal framework for handling hazardous waste generated from any industry

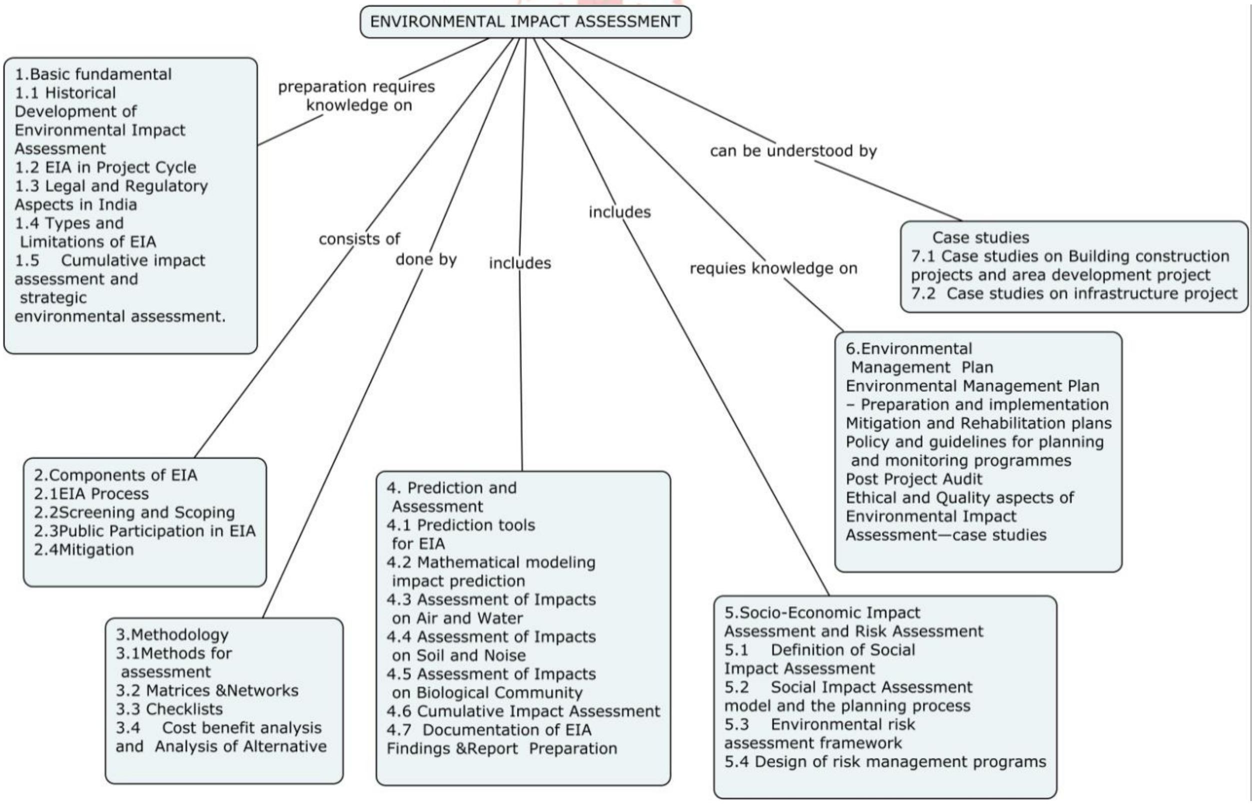
Course Outcome 3 (CO3):

1. Prepare terms of reference for coal based Thermal Power Plant having a capacity of 2x330 MW which is located at Nagapattinam district.
2. In Madurai it is propose to develop a CETP for 20 Electroplating units. Identify the potential impacts of the project and prescribe suitable terms of reference for the project.
3. It is proposed to construct a large hydro-electric power project at the foot hills of Varusanaadu. Prepare terms of reference for the socio-economic impacts.

Course Outcome 4 (CO4):

1. Pudur is a town located along the OMR road. It is proposed to construct 6000 No. of residential houses in that area. Identify the potential impacts of the project and suggest a management plan to mitigate them.
2. Sabarimalai is a pilgrimage town located in Kerala state. It is proposed to develop a Greenfield airport project for the capacity to handle six new generation large aircraft. Identify the potential impacts of the project and suggest a management plan to mitigate them.
3. Prepare risk assessment report for a stand-alone distillery unit having a capacity of 50 klpd. The raw material is sugarcane based molasses. Identify the potential impacts and prepare mitigation plan for the same.

Concept Map



Syllabus

Basic fundamentals: Historical Development of Environmental Impact Assessment-EIA in Project Cycle-Legal and Regulatory Aspects in India-Types and Limitations of EIA-Cross Sectoral Issues and terms of references in EIA**. Components of EIA environmental risk assessment**: EIA Process-Screening and Scoping-Public Participation in EIA-Mitigation. **Methodology** : Methods for Environmental assessment-Matrices &Networks-Checklists-Cost benefit analysis-Analysis of Alternative-Software Packages for EIA and Expert Systems in EIA. **Prediction and Assessment:** Prediction tools for EIA-Mathematical modeling for impact prediction-Assessment of Impacts on Air and Water-Assessment of Impacts on Soil and Noise -Assessment of Impacts on Biological Community-Cumulative Impact Assessment-Documentation of EIA Findings &Report Preparation. **Socio-economic impact assessment:** Definition of Social Impact Assessment-Social Impact Assessment model and the --planning process-Relationship between social impacts and change in community and institutional arrangements-Individual and family level impacts -Communities in transition environmental risk assessment framework. **Environmental Management Plan:** Environmental Management Plan – Preparation and implementation and Rehabilitation plans-Policy and guidelines for planning and monitoring programmes-Post Project Audit-Ethical and Quality aspects of Environmental Impact Assessment. **Case studies.**

Text Books

1. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York, 1996.

Reference Books

2. Lawrence, D.P., Environmental Impact Assessment – Practical Solutions to recurrent problems, Wiley-Interscience, New Jersey, 2003.
3. Petts, J., Handbook of Environmental Impact Assessment, Vol., I and II, Blackwell science, London, 1999.
4. World Bank – Source Book on EIA.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.Basic Fundamentals		
1.1	Historical Development of Environmental Impact Assessment	1
1.2	EIA in Project Cycle	1
1.3	Legal and Regulatory Aspects in India –Recent Amendments.	2
1.4	Types and Limitations of EIA	1
1.5	Cumulative impact assessment and strategic environmental assessment.	1
2.Components of EIA		
2.1	EIA Process	1
2.2	Screening and Scoping	1

2.3	Public Participation in EIA	2
2.4	Mitigation	1
3.Methodology		
3.1	Methods for Environmental assessment	1
3.2	Matrices &Networks	1
3.3	Checklists	1
3.4	Cost benefit analysis and Analysis of Alternative	1
4. Prediction and Assessment		
4.1	Prediction tools for EIA-RIAM	1
4.2	Mathematical modeling for impact prediction	1
4.3	Assessment of Impacts on Air and Water	1
4.4	Assessment of Impacts on Soil and Noise	1
4.5	Assessment of Impacts on Biological Community	1
4.6	Cumulative Impact Assessment	1
4.7	Documentation of EIA Findings &Report Preparation	1
5.Socio-Economic Impact Assessment and Risk Assessment		
5.1	Definition of Social Impact Assessment	1
5.2	Social Impact Assessment model and the planning process	2
5.3	Environmental risk assessment framework	1
5.4	Design of risk management programs	1
6.Environmental Management Plan		
6.1	Environmental Management Plan – Preparation and implementation	1
6.2	Mitigation and Rehabilitation plans	1
6.3	Policy and guidelines for planning and monitoring programmes	1
6.4	Post Project Audit and Environmental audit.	1
6.5	Ethical and Quality aspects of Environmental Impact Assessment—case studies	1
	7.Case studies	
7.1	Case studies on Building construction projects and area development project	2

7.2	Case studies on infrastructure project	2
	TOTAL	**36**

Course Designers

Dr. S. Chandran schandran@tce.edu

Mr. V. Ravi Sankar environmentengr@tce.edu

14CEPL0	BRIDGE ENGINEERING	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

Bridge is a structure built to span physical obstacles without closing the way underneath such as a body of water, valley, or road, for the purpose of providing passage over the obstacle. There are many different designs that each serve a particular purpose and apply to different situations. Designs of bridges vary depending on the function of the bridge, the nature of the terrain where the bridge is constructed and anchored, the material used to make it, and the funds available to build it. This course offers the design of bridges such as RCC bridges, design principles of steel and prestressed concrete bridges, design principles of substructure and design of different types of bearings as per IRC loadings standards, Indian Railway standards bridge rules and MOST codes. It aims at determination of safe as well as economical section using different kinds of material used in construction and maintenance.

Prerequisite

Strength of Materials 14CE220 Mechanics of Solids 14CE321, Structural Analysis 14CE420, Design of RCC 14CE610, Design of Steel Structures 14CE670 and Prestressed Concrete 14CEPF0

Course Outcomes

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

			Expected Attainment Level(%)	Expected Proficiency Level (grade)
CO1	Identify the type of bridge and its basic requirements for particular location	Understand		
CO2	Design the culverts and deck slab bridges	Create		
CO3	Design the long span bridges	Create		
CO4	Demonstrate the design principles of steel bridges	Apply		
CO5	Explain the design principles of prestressed concrete bridges	Apply		
CO6	Design the bridge bearings and piers	Create		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO13.	L	L	L	L	L	L	L	L	L	L	L	L		
CO14.	S	S	S	S	M	S	S	S	S	S	S	S		
CO3.	S	S	S	S	M	S	S	S	S	S	S	S		
CO4.	S	M	M	M	S	S	S	S	S	S	S	S		
CO5.	S	M	M	M	S	S	S	S	S	S	S	S		
CO6.	S	S	S	S	M	S	S	S	S	S	S	S		

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	**10**	**10**	**10**	**10**
Understand	**10**	**10**	**10**	**10**
Apply	**40**	**40**	**40**	**40**
Analyse	**-**	**-**	**-**	**-**
Evaluate	**-**	**-**	**-**	**-**
Create	**40**	**40**	**40**	**40**

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define linear waterway.
2. State the minimum width of carriage way for single lane traffic?
3. Explain in detail the points to be considered while selecting an ideal bridge site?

Course Outcome 2 (CO2):

1. Draw a neat sketch of a bridge and mark all its components, also explain the importance of each component.
2. List out the various components of slab culvert.
3. Design a deck slab bridge for the following data:

Clear distance between abutments: 7m

Road : NH (Two Lane)

Foot path : 1m on either side

Width of bearing : 400 mm

Wearing coat : 80mm average

Loading : IRC Class AA (Tracked)

Materials : M30 concrete and Fe 415 Steel

Course Outcome 3 (CO3):

1. Draw the position of IRC class 'AA' Tracked vehicle wheel load for getting maximum bending moment.
2. Design the articulation of balanced cantilever bridge of span 70 m, carriage way two lanes, loading class 70R tracked vehicle, Materials: M25 grade concrete and Fe415 steels are used.
3. List any two advantages of balanced cantilever bridge.

Course Outcome 4 (CO4):

1. Draw the neat of truss bridge.
2. Explain the loads considered in Railway bridges.
3. What are the factors to be considered in selecting paint for steel bridge?

Course Outcome 5 (CO5):

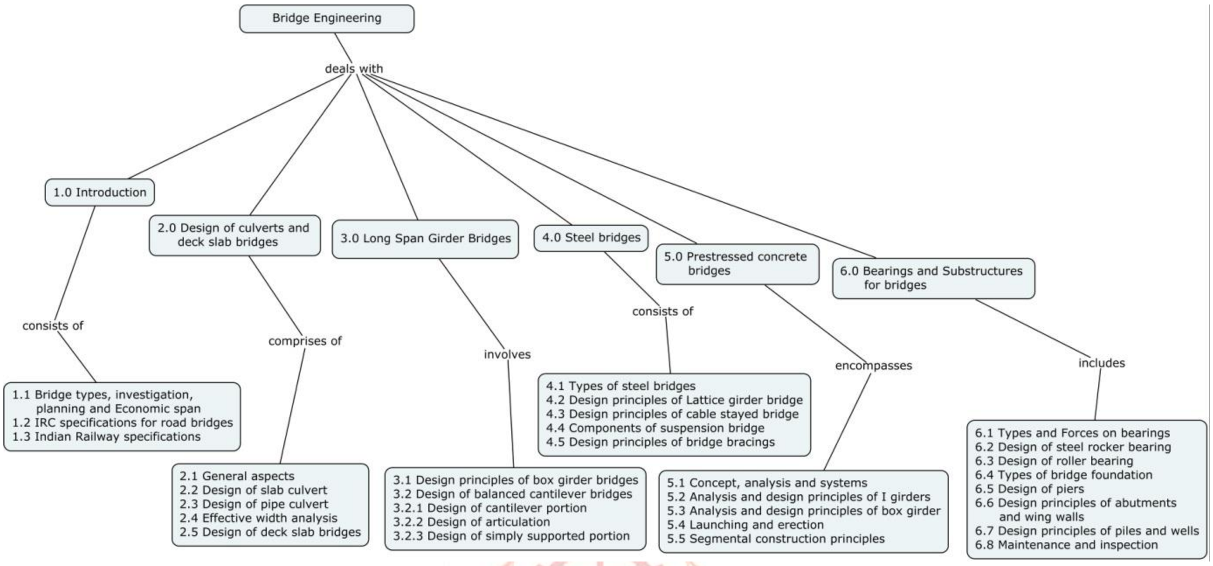
1. Give the advantages of prestressed concrete bridges.
2. Define the terms: Maximum and Minimum prestressing forces.
3. Explain in detail in finding the eccentricity of cables in prestressed concrete bridges.

Course Outcome 6 (CO6):

1. Write the equation for calculating the scour depth for natural streams in alluvial soil.
2. List out the various classification of a fixed bearings.

3. Design a R.C rocker bearing to transmit a support reaction of 1000 kN.permissible bearing stress in concrete is 8 Mpa. Use M30 grade concrete and Fe 415 grade steel.
4. Draw typical sketch of different types of pier.

Concept Map



Syllabus

Introduction: Classification of bridges, investigations and planning, linear water way, economic span length**-** IRC specifications for road bridges -standard live loads, other forces acting on bridges - Indian Railway codal provisions for broad gauge single line and double line, general design considerations **Design of culverts and deck slab bridges:** General aspects - design of slab culvert - design of pipe culvert- slab design as effective width analysis - design of deck slab bridges for IRC loadings **Long Span Girder Bridges:** Design principles of box girder bridges- design of balanced cantilever bridges- cantilever portion – articulation - simply supported portion **Steel bridges:** Types of steel bridges - design principles of lattice girder bridges - cable stayed bridge - components of suspension bridge - design of bridge bracings **Prestressed concrete bridges:** Concept, analysis and systems - analysis and design principles of I girders - analysis and design principles of box type girder - launching and erection details with case studies - segmental construction principles **Bearings and substructures for bridges:** Types of bearings, forces on bearings, basis for selection of bearings - design of steel rocker bearing - design of roller bearing - Types of bridge foundation - design of piers - design principles of abutments and wing walls **-** piles and wells - general features - maintenance and inspection of bridges.

Text Book

1. Krishna Raju. N. “Design of Bridges”, 4th Edition, Oxford & IBH, New Delhi 2010.
2. Johnson Victor.D, “Essentials of Bridge Engineering”, 6th Edition, Oxford & IBH Publishers Co. Pvt. Ltd, New Delhi 1999.
3. Ponnuswamy.S., “Bridge Engineering”, 2nd Edition, Tata McGraw Hill Publications, New Delhi, India 2007

Reference Books

1. Aswanin.Mc, Vazarani.V.N and Ratwani.MM, “Design of Concrete Bridges”, 2nd Edition, Khanna Publishers, New Delhi, India, 2004.
2. Jagadeesh.F.R., Jay Ram.M.A, “Design of Bridge Structures”, 2nd Edition, Eastern Economy Edition, New Delhi, India, 2009.
3. Raina,Concrete.V. K. “Bridge Design and Practice”, 3rd Edition, Shroff Publishers, India

2010
4. Rowe, R. E.," Concrete Bridge Design", C.R. Books Ltd. London 2002.

List of National and International Standards

1. IRC: 78, "Standard specifications & Code of practice for Road Bridges".
   a. Section VII-Foundation and Substructures.
2. IRC: 6-2000, " Standard specifications & Code of practice for Road Bridges".
   a. Section II-Loads and Stresses.
3. IRC: 21-2000, " Standard specifications & Code of practice for Road Bridges".
   a. Section III-Cement Concrete (Plain and Reinforced).
4. IRC: 83 Part II-1987, "Standard specifications & Code of practice for Road Bridges".
   a. Section : 9 Bearing, Part II – Elastomeric Bearings.
5. IRC: 45-1972, " Recommendations for Estimating the resistance of soil below the maximum scour level in the Design of Well foundations of Bridges.
6. IRC: 24-2000 "Standard specifications & code of practice for steel bridges".
7. IRC: 87-1984, "Guidelines for the Design and Erection of False work for Road Bridges.
8. IS 1343:1980 Code of Practice for Pre Stressed Concrete
9. IRS: 1 1977, Bridge rules.
10. IRS: 2, "Code of practice for plain, reinforced and prestressed concrete for general bridge construction.
11. MOST standard plans for 3.0m to 10m span reinforced cement concrete solid slab superstructure with and without foot paths for highways, (1991).
12. MOST standard plans for highways bridges RCC.T-Beams and slab superstructure – span from 10m to 24m width.
13. MOST standard plans for highway bridges PSC girder and RC slab composite superstructure for 30m span with and without foot paths, 35m span with footpaths, 40m span without foot paths, 1992.
14. MOST standard drawings for road bridges- RCC solid slab superstructure (15° and 30° SKEW) span 4m to 10m (with and without foot paths), 1992.
15. MOST standard drawing for road bridges-RCC solid slab superstructure (22.5°SKEW) span 4m to 10m (with and without foot paths), 1996.
16. IS 2911, 1980 code of practice for pile foundation.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.0	**Introduction**	
1.1	Classification of bridges, investigations and planning, linear water way, economic span length	1
1.2	IRC specifications for road bridges - standard live loads, other forces acting on bridges	1
1.3	Indian Railway codal provisions for broad gauge single line and double line, general design considerations	1
2.0	**Design of culverts and deck slab bridges**	

2.1	General aspects	1
2.2	Design of slab culvert	2
2.3	Design of pipe culvert	2
	Design of deck slab bridges	
2.4	Slab design as Effective width analysis	2
2.5	Design of deck slab bridges for IRC loadings	2
3.0	**Long Span Girder Bridges**	
3.1	Design principles of box girder bridges	1
3.2	Design of balanced cantilever bridges	
3.2.1	Design of cantilever portion	2
3.2.2	Design of articulation	2
3.2.3	Design of simply supported portion	1
4.0	**Steel bridges**	
4.1	Types of steel bridges	1
4.2	Design principles of Lattice girder bridges	1
4.3	Design principles of cable stayed bridge	1
4.4	Components of suspension bridge	1
4.5	Design principles of bridge bracings	2
5.0	**Prestressed concrete bridges**	
5.1	Concept, analysis and systems	1
5.2	Analysis and design principles of I girders	1
5.3	Analysis and design principles of box type girder	1
5.4	Launching and erection details with case studies	1
5.5	Segmental construction principles	1
6.0	**Bearings and Substructures for bridges**	
6.1	General features - Types of bearings, Forces on bearings, Basis for selection of bearings	1
6.2	Design of steel rocker bearing	1
6.3	Design of roller bearing	1
	Substructures for bridges	

6.4	Types of bridge foundation	1
6.5	Design of piers	2
6.6	Design principles of abutments and wing walls	1
6.7	Design principles of piles and wells	1
6.8	Maintenance and inspection of bridges	1
	TOTAL	**36**

Course Designers:

1. Dr. K.Sudalaimani ksudalaimani@tce.edu
2. Ms.M.Vigneshwari mvigneshwari@tce.edu

		Category	L	T	P	Credit
14CEPM0	**EARTHQUAKE ENGINEERING**	PE	3	0	0	3

Preamble

One of the major destructive forces that damage the Infra structure is earthquake. Therefore the structures in earthquake prone areas need to be designed to resist this unpredictable natural force. Earthquake-resistant design of structures has grown into a true multi disciplinary field of engineering wherein many exciting developments are possible in the near future. This subject introduces the concepts of seismic-resistant design and provides minimum standards for use in building design to maintain public safety in an extreme earthquake. Further methods of analysis and determinant internal forces in structural members due to earthquake the approximate design, detailing are introduced

Course Outcomes

At the end of the course the student will be able to

			Expected Attainment level (%)	Expected Proficiency level(grade)
CO1	Explain the seismicity in the world, both inter-plate and intra-plate.	Understand	70	A
CO2	Identify hazards to buildings caused by earthquakes.	Apply	70	A
CO3	Interpret response spectra presented in different formats, including the Acceleration-Displacement Response Spectrum (ADRS) diagram	Apply	70	A
CO4	Explain the principle of seismic measuring instruments	Understand	70	A
CO5	Apply the principle of vibration to build structures	Apply	70	A
CO6	Compute the detailing of reinforcement in beams, columns and beam column joints	Apply	70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO15.	-	-	-	-	-	L	-	-	-	L	L	-	-	L
CO16.	-	-	-	-	-	S	-	-	-	L	-	-	-	M
CO3.	-	M	-	-	-	L	-	-	-	L	-	-	L	L
CO4.	L	L	-	-	-	-	-	-	-	L	-	-	L	L
CO5.	L	M	-	-	-	M	-	-	-	L	L	-	L	L
CO6.	L	L	-	-	-	M	-	-	-	L	L	-	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

S.No.	Bloom's Category	Test 1	Test 2	End semester Examination
1	Remember	20	20	20
2	Understand	20	20	20
3	Apply	60	60	60
4	Analyse	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Course Level Learning Objectives

Course Outcome (CO1)

1. Define centre of mass and Centre of rigidity.
2. What is meant by 'torsional effect' on buildings?
3. What is meant by Soil friction?
4. Write short notes on passive earth pressure.
5. Define modal mass and modal participation factor.

Course Outcome (CO2)

1. Differentiate foreshocks and aftershocks.
2. Define liquefaction.
3. Write short notes on soil-structure interaction
4. What are the types of bands normally used for masonry structures?
5. Define ductility.

Course Outcome (CO3)

1. An industrial multi-storeyed building 25m high is to be designed in Assam. Compute the a. Seismic force by static method b. Modal mass and modal participation factors for the following details. (T=0.820)
   - Live load 250kg/m2
   - Beam size 25 x 35 mm
   - Column size 30 x 40mm
   - Slab thickness 18mm
   - Wall thickness 15mm

Course Outcome (CO4)

1. Analyze a three storied RC building by static method and also determine modal mass and modal participation factor as per IS 1893 (PART 1): 2002 for the following data.

   Seismic zone = IV

   Floor height = 4.0m

   Length of building = 10m

   Infill wall = 250mm thick in longitudinal and 150mmmm in transverse direction.

   Imposed load = 3.5 kN/m^2

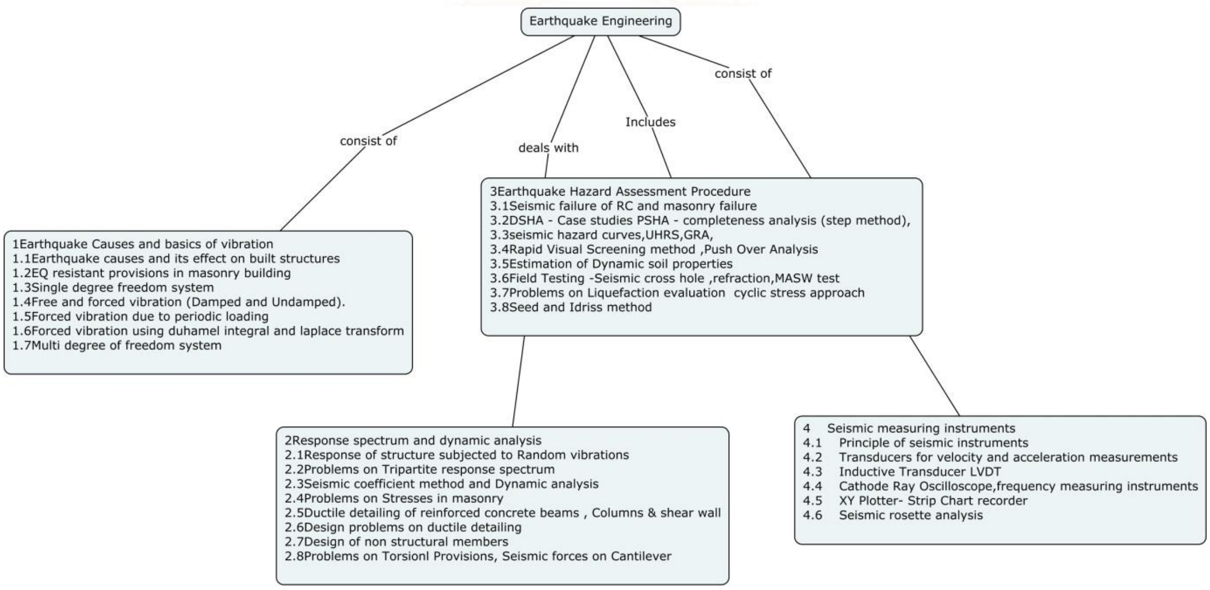
   Size of columns = 250mm x 400mm.

   Size of beams = 300mm x 400mm in longitudinal and 300mm x 350mm in transverse direction

   Depth of slab = 120mm .

2. Design for lintel and Roof band of a single room building of size 6.m x 4m. The walls are 200mm thick in modular bricks built in 1:5 cement sand mortar. The height of building up to lintel level is 3m and the vertical distance between the roof band and lintel band is 1.5m.The roof band weighs 750 kg/ m$^{2.}$ The bands are required for a design earthquake coefficient of 0.12. Weight of wall is 450 kg/ m^2 .Weight of masonry is 1900 kg/ m^2.

Concept Map



Course Content and Lecture Schedule

S.NO	TOPICS	PERIODS
1	**Earthquake Causes and basics of vibration**	
1.1	Earthquake causes and its effect on built structures	1

1.2	EQ resistant provisions in masonry building	1
1.3	Single degree freedom system	1
1.4	Free and forced vibration (Damped and Undamped).	1
1.5	Forced vibration due to periodic loading	1
1.6	Forced vibration using duhamel integral and laplace transform	1
1.7	Multi degree of freedom system	1
2	**Response spectrum and dynamic analysis**	
2.1	Response of structure subjected to Random vibrations	1
2.2	Problems on Tripartite response spectrum	1
2.3	Seismic coefficient method and Dynamic analysis	3
2.4	Problems on Stresses in masonry	2
2.5	Ductile detailing of reinforced concrete beams , Columns & shear wall	1
2.6	Design problems on ductile detailing	1
2.7	Design of non structural members	1
2.8	Problems on Torsionl Provisions, Seismic forces on Cantilever	2
3	**Earthquake Hazard Assessment Procedure**	
3.1	Seismic failure of RC and masonry failure	1
3.2	DSHA - Case studies PSHA - completeness analysis (step method),	1
3.3	seismic hazard curves,UHRS,GRA,	1
3.4	Rapid Visual Screening method ,Push Over Analysis	1
3.5	Estimation of Dynamic soil properties	2
3.6	Field Testing -Seismic cross hole ,refraction,MASW test	2
3.7	Problems on Liquefaction evaluation cyclic stress approach	1
3.8	Seed and Idriss method	1
4	**Seismic measuring instruments**	
4.1	Principle of seismic instruments	1
4.2	Transducers for velocity and acceleration measurements	1
4.3	Inductive Transducer LVDT	1
4.4	Cathode Ray Oscilloscope,frequency measuring instruments	2

4.5	XY Plotter- Strip Chart recorder	1
4.6	Seismic rosette analysis	1
	Total	36

Syllabus

Earthquake Causes and basics of vibration-Earthquake causes and its effect on built structures-EQ resistant provisions in masonry building-Single degree freedom system-Free and forced vibration-Forced vibration using duhamel integral and laplace transform-Multi degree of freedom system**Response spectrum and dynamic analysis-**Response of structure subjected to Random vibrations-Problems on Tripartite response spectrum-Seismic coefficient method and Dynamic analysis-Ductile detailing of reinforced concrete beams , Columns & shear wall-Design problems on ductile detailing-Design of non structural members-Problems on Torsionl Provisions, Seismic forces on Cantilever**Earthquake Hazard Assessment Procedure-**Seismic failure of RC and masonry failure-DSHA - Case studies PSHA - completeness analysis-Rapid Visual Screening method ,Push Over Analysis-Estimation of Dynamic soil properties-Field Testing -Seismic cross hole ,refraction,MASW test-Seed and Idriss method**Seismic measuring instruments-**Principle of seismic instruments-Transducers for velocity and acceleration measurements-Inductive Transducer LVDT-Cathode Ray Oscilloscope,frequency measuring instruments-XY Plotter-Strip Chart recorder

Reference Books:

1. PankajAgarwal, Manish Shrikhande , “Earthquake resistant design of structures”, Prentice Hall, India, 2006.
2. James Ambrose and DemitryVergun, “Earthquake retaining structures”, Johnwilley& sons 2001.
3. Hemant Kumar Sharma, &GiridharilalAgarwal, “Earthquake Resistant Building construction”, Vedha publications New Delhi. 2001.
4. Polyahov S., “Design of Earthquake Resistant Structures”, John willey& sons, 1993.
5. Green, “Earthquake Resistant Building Design”,Johnwilley& sons
6. Alan Williams, Ph.D. Williams Alan, “Siesmic Design of Buildings and Bridges: For Civil and Structural Engineers”.
7. Website- www.nicee.org

IS Codes:

1. IS: 13920:1993, “Code of Practice for ductile detailing of Reinforce Concrete-Structures subjected to Seismic forces”,
2. IS 4326:1993 Code of Practice for “Earthquake Resistant Design and Construction of Buildings.
3. IS: 1893: 2000 – Indian Standard Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi.
4. IS: 13828: 1993 – Improving Earthquake Resistance of Low Strength Masonry Buildings.
5. IS: 13827: 1993. - Improving Earthquake Resistance of Earthen Buildings,1993.

Course Designers:

Dr.R.Ponnudurai rpdciv@tce.edu

14CEPN0	DISASTER MITIGATION AND MANAGEMENT	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course deals with the various disasters and to expose the students about the measures, its effect against built structures, and Hazard Assessment procedure in India. This course also deals with the methods of mitigating various hazards such that their impact on communities is reduced.

Course Outcomes

At the end of the course the student will be able to

			Expected Attainment level (%)	Expected Proficiency level (grade)
CO1	Understand the various types of disaster viz Hydrological, Coastal and Marine Disasters, Atmospheric Disasters, Geological, Mass Movement and Land Disasters, Wind and Water Driven Disasters	Understand	70	A
CO2	Identify the potential deficiencies of existing buildings for Earthquake disaster and suggest suitable remedial measures.	Understand	70	A
CO3	Derive the guide lines for the precautionary measures and rehabilitation measures for Earthquake disaster.	Apply	70	A
CO4	Derive the protection measures against floods, cyclone, land slides	Apply	70	A
CO5	Understand the effects of disasters on built structures	Understand	70	A
CO6	Understand the hazard Assessment procedure	Understand	70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO_1	PSO_2
CO1	M	-	-	L	-	-	-	-	-	-	-	-	L	-
CO2	M	M	L	L	-	M	-	-	-	-	-	-	L	-

CO3	S	M	S	M	-	L	-	M	-	-	-	-	M	L
CO4	S	M	S	M	-	L	-	M	-	-	-	-	M	L
CO5	L	L	-	L	-	-	-	-	-	-	-	-	L	-
CO6	L	-	-	-	-	-	-	-	-	-	-	-	L	-

S- Strong; M-Medium; L-Low

Assessment Pattern

S.No.	Bloom's Category	Test 1	Test 2	End semester Examination
1	Remember	20	20	20
2	Understand	80	60	60
3	Apply	0	20	20
4	Analyse	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Course Level Learning Objectives

Course Outcome (CO1)

1. What is Richter Magnitude?
2. What is Peak ground Acceleration?
3. What is meant by *hazard mitigation*?
4. What is a Local Hazard Mitigation Plan?

Course Outcome (CO2)

1. List the different types of droughts and highlight its various causes.
2. Define community Contingency Plan
3. How does the site soil affect the EQ response of structures?
4. Explain the classification and causes of landslides indicating the places where they could occur in India.

Course Outcome (CO3)

1. Explain the plan, Mass and Geometric irregularities in the RC buildings. How these irregularities adversely affect the performance of the RC buildings during Earthquake
2. Discuss the various types of natural disasters and highlight the specific efforts to mitigate disasters in India

Course Outcome (CO4)

1. Describe various types of hazards and impacts associated with earthquakes and highlight the lessons learnt
2. Briefly explain the components of follow-up activities in psychological rehabilitation of disaster affected people.

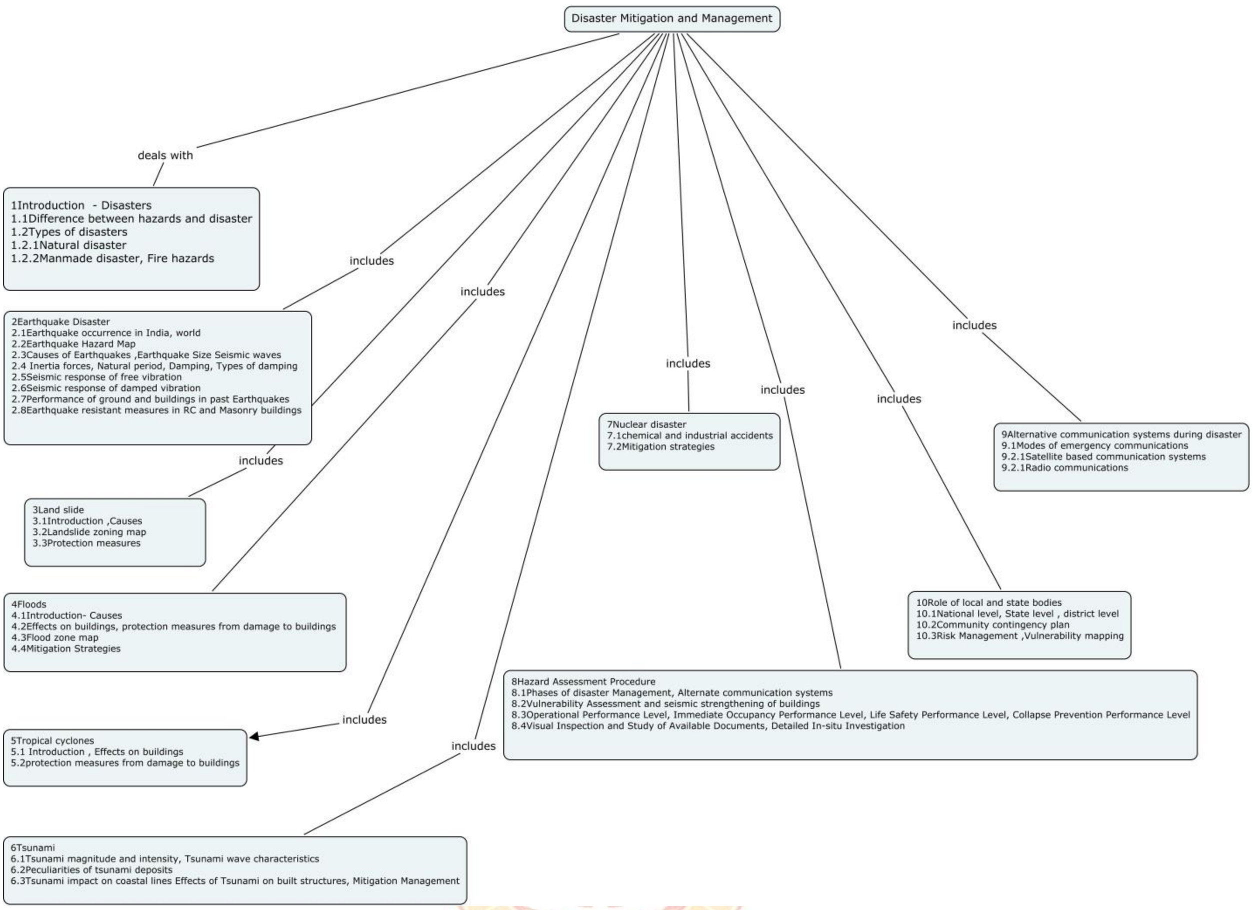
Course Outcome (CO5)

1. If you were the relief commissioner of the state of Assam which is affected by floods every year list out five departments that you need to contact.
2. Identify four different task forces and list out two responsibilities of each of the task forces
3. Do you think disaster risk can be reduced through community participation? Discuss

Course Outcome (CO6)

1. Which areas are more prone to heat and cold waves in India? Discuss the preventive and preparedness measures that are mostly adopted for protection from heat and cold waves
2. Explain the role of central Government in responding to disasters
3. Describe suitable mitigation and preparedness measures that the community should take in advance to guard a EQ disaster occurring again.

Concept Map



Course Content and Lecture Schedule

Module No.	Topics	No. of Lectures
1	**Introduction - Disaster**	
1.1	Over view of Disaster Management	1
2	**Land slide**	
2.1	Introduction ,Causes,types,preparation of hazard zonation map	1
2.2	Liquefaction -remedial options	1
2.3	Liquefaction related phenomena	1
2.4	Evaluation of Liquefaction hazards and Liquefaction resistance	1
2.5	Slope failures	1
3	**Floods**	
3.1	Introduction- Causes -Rescue and relief Management	1
3.2	Effects on buildings, protection measures from damage to buildings	1
3.3	Case studies	1

4	**Earthquake Disaster**	
4.1	Causes of Earthquakes ,Earthquake Size Seismic waves	1
4.2	Earthquake resistant measures in RC and Masonry buildings	1
4.3	Seismic response of free and forced damped vibration	1
5	**Tropical cyclones**	
5.1	Introduction , Effects on buildings, Warning systems in India	1
5.2	Damaging effects of cyclone	1
5.3	Design procedure for wind resistant buildings	1
6	**Tsunami**	
6.1	Tsunami causes ,Warning systems DART floating bouys	1
6.2	Tsunami impact on coastal lines Effects of Tsunami on built structures	1
7	**Man made Disaster - Industrial accident case study**	1
7.1	NBC,Radioactivity,Alpha ,Beta , Gamma decay,fission and fusion	1
7.2	Chemical warfare agents,universal classification of hazard substances and explosives,decontamination procedure - BW agents -Emergency Medical responder,Vital signs (RPSPBP)	2
7.3	Classification of Hazardous chemicals	1
8	**CSSR -Collapsed Structure & Rescue operations**	
8.1	Search and rescue and evacuation methods	1
8.2	Fire safety technique classification Extiguishers	1
8.3	Life saving skills - Body mechanics - CPR - Burn and its classification	1
9	**Role and responsibility of NDRF**	1
9.1	Skill variety of NDRF Battalions-MFR-FRRM,CBRN disasters	1
9.2	START system,TRIAGE,FBAO(Foreign body airway Obstruction	1
9.3	Community training	1
10	**Hazard Assessment Procedure**	
10.1	DSHA - Case studies	1
10.2	PSHA - completeness analysis (step method),	1
10.3	seismic hazard curves,UHRS,GRA,	1

10.4	RVS,Push Over Analysis	1
10.5	Policy and procedures	1
10.6	Role of Local and state bodies,Alternate communication systems	1
10.7	Community planning Community Contingency plan	1
	TOTAL	**36**

Syllabus

Introduction -Introduction-Difference between hazards and disaster –Types of disasters-Phases of disaster Management -Hazards -Classification of Hazards - Hazards affecting buildings - Building safety against hazards –Floods – Cyclone – Landslides –Tsunami Fire hazards **Earthquake Disaster -** Earthquake Hazard Map -Causes of Earthquakes -Classification of Earthquakes - -Seismic waves -Energy release - Inertia forces, Natural period -Resonance, Damping -Seismic response of free vibration -Seismic response of damped vibration -Performance of ground and buildings in past Earthquakes-Earthquake resistant measures in RC and Masonry buildings -Potential deficiencies of RC and Masonry buildings **Landslides –** Landslide zoning map **-** Causes –Protection measures **Floods –** Flood zone map **-** Effects on buildings – protection measures from damage to buildings – Mitigation Strategies

Tropical cyclones - Effects on buildings – protection measures from damage to buildings **Tsunami -** Tsunami magnitude and intensity -Tsunami wave characteristics -Peculiarities of tsunami deposits -Tsunami impact on coastal lines -Effects of Tsunami on built structures – Mitigation Management **Nuclear disaster** – chemical and industrial accidents - Mitigation strategies **Hazard Assessment -** Vulnerability Assessment and seismic strengthening of buildings -Vulnerability Assessment of Buildings procedure -Hazard Assessment-Visual Inspection and Study of Available Documents-Detailed In - situ Investigation Planning and Interpretation of Results-Foundation Capability -Non- structural Components -Seismic Strengthening of Buildings-Repairs Restoration Strengthening of Existing Buildings Strengthening Materials-Retrofitting of Load Bearing Wall Buildings Retrofitting of RC Buildings- **Alternative communication systems during disaster-** Modes of emergency communications-Satellite based communication systems -Radio communications **Role of local and state bodies**Natioanallevel,State level , district level -Community contingency plan –Risk Management - Vulnerabilty mapping.

Reference Books:

1. Ray.N.Glough, Joseph Penzein, (1996), “Dynamics of Structures”, McGraw Hill International Ltd.
2. Jaikrishna & A.R.Chandrasekaran, (1996) “Elements of Earthquake Engineering”, SaritaPrakashan, Meerut.
3. Berg.GV (1982), “Seismic Design codes and procedures”, EERI, CA.
4. Booth, Edmund (1994), “Concrete Structures in earthquake regions; Design and Analysis”, Longman.

5. Dowrick. D.J (1987), “Earthquake resistant design for Engineers and Architects”,John Wiley & Sons, Second Edition.
6. G.K. Ghosh(1993) “Disaster Management” A.P.H. Publishing Corporation,New Delhi
7. R.B. Singh (1992)“Disaster Management” Rawat Publications,New Delhi
8. Ayaz Ahmad(1990) Disaster Management: Through the New Millennium By Anmol Publications, New Delhi
9. Goel, S. L.(1991) “Encyclopaedia of Disaster Management” Deep & Deep Publications Pvt Ltd,New Delhi

IS Codes:

1. IS: 4326-1984, “Indian Std Code of practice for Earthquake Resistant Design and Construction of Buildings”.
2. IS: 1893 (Part I)-2002 “Code of practice for Earthquake Resistant Design of Structures

Course Designers:

Dr.R.Ponnudurai rpdciv@tce.edu

14CEPP0	BUILDING PLANNING AND SERVICES	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course work imparts knowledge required for understanding the general principles of building planning and services with the help of relevant codes, manuals and guidelines.

Prerequisite

Nil

Course Outcomes

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

			Expected Attainment Level (%)	Expected Proficiency Level(grade)
CO1	Understand the general planning and development control rules for different types of buildings	Apply	**70**	**A**
CO2	Apply the relevant codes and manuals for the design of building services	Apply	70	A
CO3	Apply the principles of electrical and lighting services for different uses in buildings	Apply	70	A
CO4	Apply the principles of planning ser vices for domestic and industrial needs	Apply	70	A
CO5	Plan and design the requirements for HVAC system ,firefighting and other necessary services for various types of buildings	Apply	70	A
CO6	Incorporate the integrated planning and designing of necessary building services for better usage of building	Apply	70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO_1	PSO_2
CO17	L	L	-	-	-	M	M	S	L	L	-	-	L	M
CO18	L	L	-	-	-	M	M	M	M	L	-	L	L	M
CO3	M	M	S	L	-	M	M	M	L	M	-	L	M	M
CO4	M	M	S	L	-	M	M	M	L	M	-	L	M	M
CO5	M	M	S	L	-	M	M	M	L	M	-	L	M	M
CO6	M	S	S	S	-	M	M	M	M	M	-	M	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	**20**	**20**	**20**	**20**
Understand	**50**	**50**	**50**	**40**

Apply	**30**	**30**	**30**	**40**
Analyse	**-**	**-**	**-**	**-**
Evaluate	**-**	**-**	**-**	**-**
Create	**-**	**-**	**-**	**-**

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. List the types of land use according to Building Development Control Rules
2. Discuss the regulations with respect to fire safety in buildings
3. Discuss the planning considerations to be made in buildings based on codal provisions on fire safety

Course Outcome 2 (CO2)

1. Explain the need and details of earthing to a building as per IS specifications
2. Specify the minimum levels of illumination for different buildings as per NBC
3. Discuss the various water conservation measures applied to an Educational Institute with hostel facility?

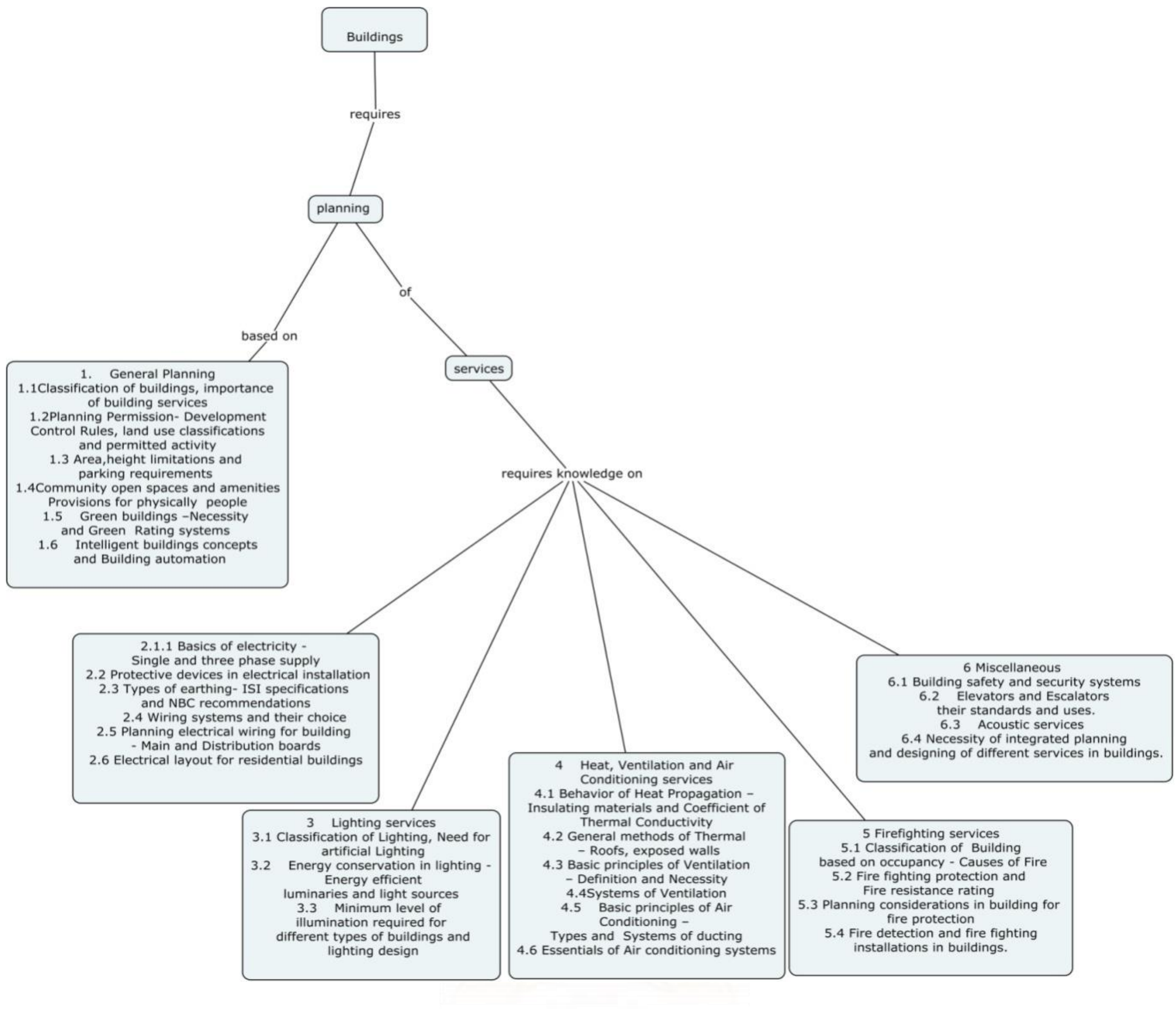
Course Outcome 3 (CO3)

1. Assume an IT building is to be constructed in a metropolitan area of 20,000 sq.m. The width of road in front is 15 m. Plan the building according to F.S.I and height restrictions. Justify your recommendations
2. Select a suitable wiring system for a building having a connected load of 500kW. Make suitable assumptions. Justify your selection
3. Suggest suitable fire fighting installations needed for a commercial complex building of 4 floors

Course Outcome 4 (CO4)

1. Discuss the regulations with respect to fire safety in buildings
2. Discuss the planning considerations to be made in buildings based on codal provisions on fire safety
3. Plan and draw an electrical layout for a residential building considering the essential electrical points in various rooms

Concept Map



Syllabus

General Planning:– classifications of buildings, Planning permissions, permitted activity, Area and height limitations, Community open spaces and amenities .- Green buildings- Intelligent buildings **Electrical Systems and Installations:** Basics of electricity – Single and three phase supply- Protective devices in electrical installation – types of earthing , Planning electrical wiring for building- Electrical layout for residential buildings **Lighting services:** Classification of Lighting, -Energy conservation in lighting- Minimum level of illumination required for different types of buildings. **HVAC** - Behavior of Heat Propagation, General methods of Thermal Insulation- Basic principles of Ventilation-Systems of ventilation, Basic principles and essentials of Air Conditioning **Firefighting services:** Classification of buildings based on occupancy- fire fighting protection and fire resistance rating ,planning considerations in building for Fire protection-fire detection and fire fighting installation in buildings.. **Miscellaneous:** Building safety and security systems - Elevators and Escalators their standards and uses - Acoustic services - Necessity of integrated planning and designing of different services in buildings.

Text Book

1. National Building Code of India -2005

Reference Book

1. Development Control Rules by Chennai Metropolitan Development Agency - 2006

2. Energy Conservation Building Code – 2007
3. CPHEEO Manual on Sewerage and sewage treatment systems – 2013
4. Manual for environmental clearance for large construction projects – by Ministry of environment , forest and climate change.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	**General Planning**	
1.1	Classification of buildings, importance of building services	1
1.2	Planning Permission- Development Control Rules, land use classifications and permitted activity	2
1.3	Area, height limitations and parking requirements	1
1.4	Community open spaces and amenities - Provisions for physically challenged people	2
1.5	Green buildings –Necessity and Green Rating systems	1
1.6	Intelligent buildings concepts and Building management systems.	1
2.0	**Electrical Systems and Installations**	
2.1	Basics of electricity - Single and three phase supply	1
2.2	Protective devices in electrical installation	2
2.3	Types of earthing - ISI specifications and NBC recommendations	2
2.4	Wiring systems and their choice	1
2.5	Planning electrical wiring for building - Main and Distribution boards and energy ratings for appliances.	1
2.6	Electrical layout for residential buildings	1
3.0	**Lighting services**	
3.1	Classification of Lighting, Need for artificial Lighting	1
3.2	Energy conservation in lighting - Energy efficient luminaries and light sources	1
3.3	Minimum level of illumination required for different types of building- lighting design	2
4.0	**Heat, Ventilation and Air Conditioning services**	
4.1	Behavior of Heat Propagation – Thermal Insulating materials and Coefficient of Thermal Conductivity	1
4.2	General methods of Thermal Insulation – Roofs, exposed walls	1
4.3	Basic principles of Ventilation – Definition and Necessity	1
4.4	Systems of Ventilation	1
4.5	Basic principles of Air Conditioning – Types and Systems of ducting	1
4.6	Essentials of Air conditioning systems	1
5.0	**Firefighting services**	
5.1	Classification of Building based on occupancy - Causes of Fire	1

5.2	Fire fighting protection and Fire resistance rating	1
5.3	Planning considerations in building for fire protection	1
5.4	Fire detection and fire fighting installations in buildings.	2
6.0	**Miscellaneous**	
6.1	Building safety and security systems	1
6.2	Elevators and Escalators their standards and uses.	1
6.3	Acoustic services and	1
6.4	Necessity of integrated planning and designing of different services in buildings.	2
	TOTAL	**36**

Course designers

1. V. Ravisankar environmentengr@tce.edu
2. D. Rajkumar rajkumarcivil@tce.edu

14CEPQ0	CONSTRUCTION MANAGEMENT	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course imparts knowledge on Construction Management principles needed for execution of projects effectively and efficiently.

Prerequisite

Nil

Course Outcomes

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

		Expected Attainment level (%)	Expected Proficiency level(grade)
CO1 Enumerate the importance for management in construction industry with knowledge in sanctioning and planning of resources in projects	**Apply**	**75**	**A**
CO2 Apply knowledge of management principles in planning of resources	**Understand**	**75**	**A**
CO3 Enumerate the procedures involved in execution of construction works with various tendering and contracting systems	**Understand**	**75**	**A**
CO4 Identify and explain the process involved in measurement of construction works and maintenance of accounts	**Understand**	**75**	**A**
CO5 Identify and specify the process involved in maintenance and management of stores in construction projects	**Apply**	**75**	**A**
CO6 Apply the concepts of Gantt charts and network techniques in analyzing projects	**Apply**	**75**	**A**

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO_1	PSO_2
CO19.	L	L	-	-	-	M	M	S	-	-	-	S	L	L
CO20.	L	M	-	-	-	M	-	S	-	-	-	M	L	M
CO3.	M	L	-	-	-	-	-	S	-	-	-	S	L	M
CO4.	L	L	-	-	-	-	-	M	-	-	-	M	M	M
CO5.	S	M	M	M	M	-	-	S	-	-	-	L	L	M
CO6.	S	M	M	M	M	-	-	S	-	-	L	M	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	10

Understand	**50**	**40**	**50**	**40**
Apply	**30**	**40**	**40**	**50**
Analyse	**-**	**-**	**-**	**-**
Evaluate	**-**	**-**	**-**	**-**
Create	**-**	**-**	**-**	**-**

Course Level Assessment Questions

Course Outcome 1 (CO1)**:**

74. **Write the need and importance of managing projects in construction sector**
75. **Discuss the stages involved in execution of projects**
76. **As a project manager of a construction industry identify and discuss the functions you would exercise for successful completion of projects**

Course Outcome 2 (CO2)**:**

77. **Differentiate between the terms tenders and contracts**
78. **A mega project is proposed to be constructed worth Rs.100 crores. Suggest a suitable method of contracting of the same discussing its salient features. Justify your selection**
79. **Discuss the various deposits collected from a contractor while entering into agreement**

Course Outcome 3 (CO3)

80. **Enumerate the various methods of measurement of works**
81. **Write the meaning of M- book discussing its salient features**
82. **List the types of bills used for payment of works done**

Course Outcome 4 (CO4)**:**

1. **Identify the mode of classification of stores**
2. **Discuss the procedure for maintenance of tools and plants**
3. **During verification of stock in departments, discuss the cases likely to be encountered mentioning handling procedure**

Course Outcome 5 (CO5)**:**

1. A project consists of 12 activities. The time required for each activity is given in the table below. Use the following logical relationships and draw a network diagram for the project and determine the critical path and duration required for completion of the project.

- Activity A,D and H can be performed concurrently and represent the start of the project
- B succeeds A; C and G follow H; D,C and B precede F; L follows A; M comes after G
- K is preceded by L; X cannot start until K, F and M are completed
- Z succeeds G; X and Z are last operations

Activity	A	B	C	D	F	G	H	K	L	M	X	Z
Duration (days)	4	6	4	4	6	3	3	4	8	3	2	2

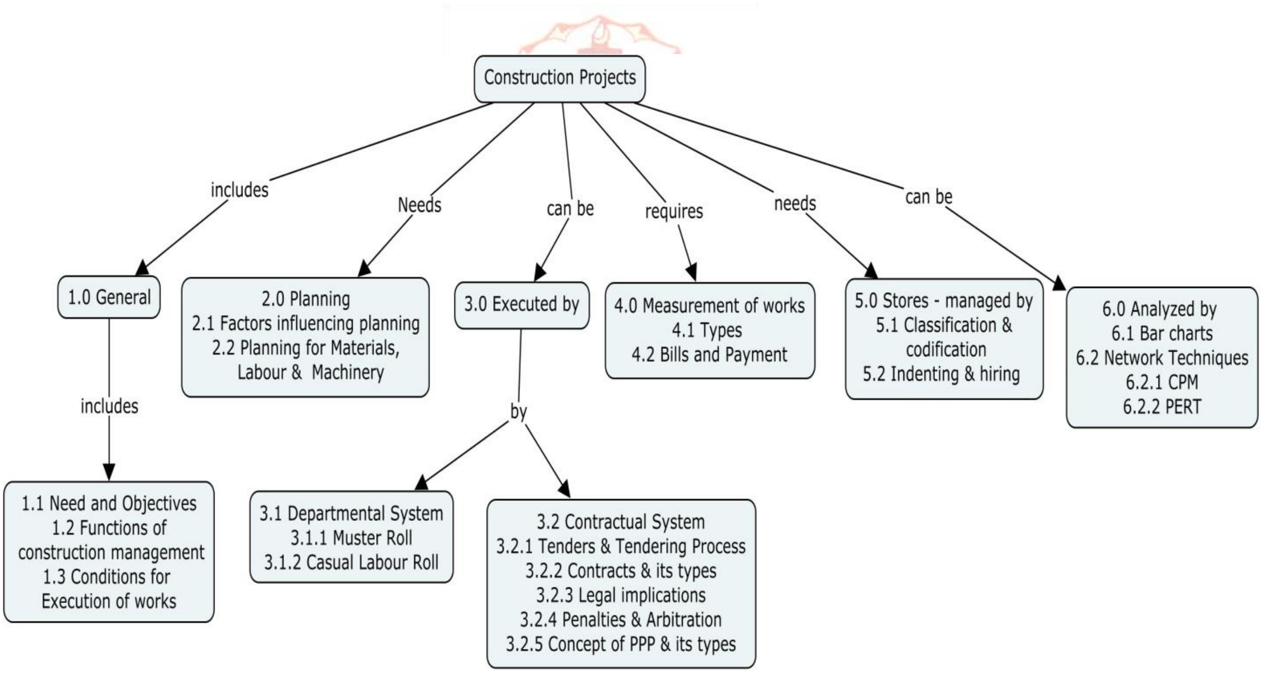
2. Write the meaning of bar charts? Discuss its limitations and methods to overcome the same

3. Conduct CPM analysis for the project using the given data and determine:

i) ES, EF, LS & LF for the activities
ii) Critical path and critical activities
iii) Total and free floats for the activities
iv) Draw the square network

Act (i-j)	10-20	10-30	20-50	20-70	30-40	30-60	40-50	50-60	50-70	60-70	70-80
Duration (days)	20	24	16	24	12	10	16	16	20	12	14

Concept Map



Syllabus

Construction Management – General Principles – need, importance, objectives & functions, Classification & stages involved in construction projects – Administrative approval – Technical and budget sanctions. – Construction team- preliminary planning of schemes – preliminary estimate- Construction planning- Materials, equipments and labour management. **Execution of works:** Methods -Departmental labour- Muster Roll system and Casual Labour system – Tender & tender document, e-tendering and contractual procedures- definition of contracts –Types of Contract, legal implications –Deposits – Earnest Money Deposit and Security Deposit – Penalties and Arbitration. Concept of Public Private Partnership - BOT, BOO, BOOT, BOLT. **Measurement of Works** – M-book, Types of measurements – original, pre and check measurement. Maintenance of Accounts – Spread sheets-Types of bills and payment – completion reports and completion certificates. **Stores**: Classification and Codification systems - Materials, tool & plants – indenting, hiring procedures, inspection and maintenance – Stock verification procedures. **Analysis of projects:** Work Breakdown

Structure, Bar-chart – concept and procedure- limitations – advantages of network analysis – CPM and PERT- concepts and procedure. Introduction to management software.

Text Book

3. S. Sangareddi and P.L. Meiyappan, “Construction Management”, Kumaran Publications, Coimbatore, 2000

Reference Books

1. B.C. Punmia and K.K. Khandelwal, “Project Planning and Control with PERT/CPM”, Laxmi publications, New Delhi, 2000
2. B.L. Gupta and Amit Gupta, “Construction Planning and Accounts”, Standard Publishers Distributors, Delhi, 1997
3. P.S. Gahlot and B.M. Dhir, “Construction Planning and Management”, New Age International Limited, Publishers, 1996
4. V.N. Vazirani and S.P. Chandola, “Construction Management and Accounts”, Khanna Publishers, New Delhi, 1986

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.0	**Construction Management**	
1.1	Need, Scope and Objectives of Construction Management- Construction resources - Construction Team	2
1.2	Functions of construction management, Types and Stages in Construction	2
1.3	Conditions for execution of works - Administrative Approval, Technical Sanction and Budget sanctions of projects	2
2.0	**Planning**	
2.1	Definition, need. Factors in Preliminary planning of schemes, preliminary estimate	2
2.2	Planning for Materials, Equipments and Labour in projects	2
3.0	**Execution of works**	
3.1	Departmental System - Muster Roll system and Casual Labour Roll system – situations of use	2
3.2	Contractual System - need	2
3.3	Tenders & Tender documents – e-tendering process	2
3.4	Contract - contract types and contractual procedures- legal implications.	2

	Concept of Public Private Partnership - BOT, BOO, BOOT, BOLT	
3.5	Deposits – Earnest Money Deposit and Security Deposit – Penalties and Arbitration	2
4.0	**Measurement of Works**	
4.1	Measurement of Works- M-book, Types of measurements – original, pre and check measurement – Spread sheets	2
4.2	Types of Bills and payments– completion reports and certificates	2
5.0	**Stores**	
5.1	Classification and Codification systems - Materials, tool & plants –inspection and maintenance.	2
5.2	Indenting, hiring procedures- Stock verification procedures	2
6.0	**Methods of Analyzing Projects**	
6.1	Origin, concept and procedure- limitations, Work breakdown Structure of projects -Problems in bar charts	2
6.2	CPM analysis of projects - Drawing of network diagrams using Fulkerson's rules- Problems in drawing of network diagrams and CPM	3
6.3	Advantages of network analysis, Comparison between PERT and CPM PERT– concept and procedure, associated probability – problems. Introduction to software	3
	Total Hours	**36**

Course Designers:

1. **Dr.G.Chitra** **gcciv@tce.edu**
2. **Mr. R. Jegan** **rjnciv@tce.edu**

		Category	L	T	P	Credit
14CEPR0	**FRACTURE MECHANICS**	PE	3	0	0	3

Preamble

The conventional design of a structure does not take in to account flaws or cracks in the materials, which largely affect the residual strength of a structure. The aim of this course is to predict the crack front growth and instability under elastic and elasto plastic conditions and to compute the stress intensity factors and stain energy release rate .This course is designed to show how these concepts can be integrated and applied to practical engineering problems using modern computational mechanics techniques.

Prerequisite

Structural mechanics, Material Science and Theory of plasticity and elasticity

Course Outcomes

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

			Expected Attainment level (%)	Expected Proficiency level (grade)
CO1	Explain the various theories of failures of structural materials with pre existing cracks	Understand	70	A
CO2	Apply the principles of Linear Elastic Fracture Mechanic in solving body with pre-existing cracks	Apply	70	A
CO3	Enumerate the physical concepts of Elastic Plastic Fracture Mechanics	Apply	70	A
CO4	Predict the Fatigue Crack Growth behaviour subjected to cyclic load	Apply	70	A
CO5	Suggest the techniques to arrest the crack propagation	Apply	70	A
CO6	Perform the numerical methods in evaluating fracture parameters	Apply	70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO21.	L	-	-	-	-	-	-	-	-	-	-	-	L	-
CO22.	S	M	-	-	-	-	-	-	-	-	-	-	M	-
CO3.	S	M	-	-	-	-	-	-	-	-	-	-	L	-
CO4.	S	M	-	-	-	-	-	-	-	-	-	-	M	-
CO5.	S	M	S	-	-	M	-	L	-	-	-	-	L	L
CO6.	S	M	-	-	-	-	-	-	-	M	-	-	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	50	50
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is fracture toughness of a material?
2. What are the modes of fracture?
3. Draw the standard test specimen for KIC testing

Course Outcome 2 (CO2):

1. What is critical stress intensity factor?
2. What is j integral?
3. What is crack tip plastic zone?

Course Outcome 3 (CO3):

1. Discuss the situation under which "K" approach becomes inapplicable.
2. Discuss the Stresses due to elliptical hole in a plate.
3. Explain Brittle to ductile transition in steel
4. Explain Load interaction and retardation in fatigue crack growth.

Course Outcome 4 (CO4):

1. Determine the energy release rate for an edge crack loaded as shown in fig.1

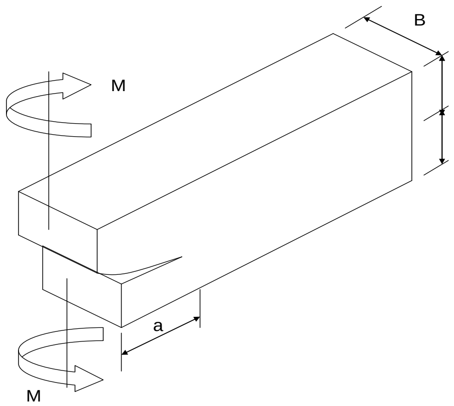


Figure 1

2. By using Westergaard approach evaluate the stresses in the vicinity of crack tip.
3. Explain how is the small scale yielding at the crack tip is taken care by Irwin. Illustrate its physical significance.

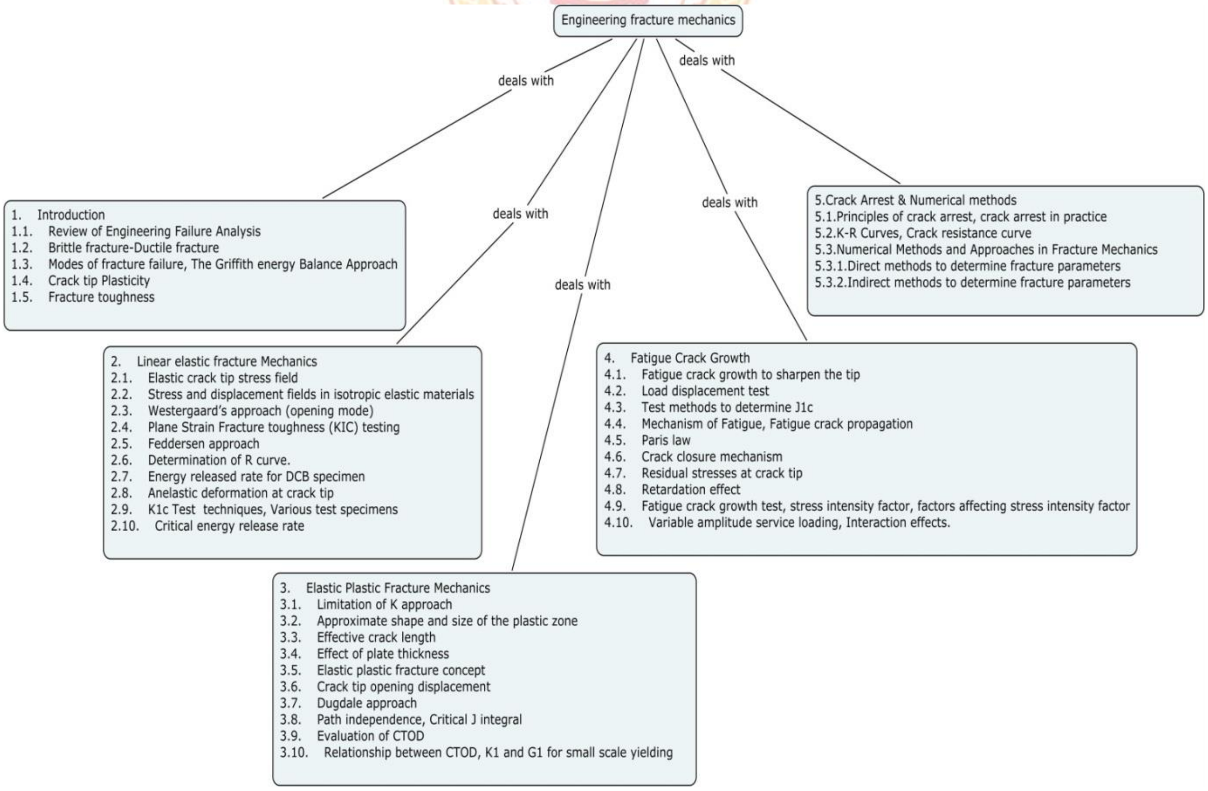
Course Outcome 5 (CO5):

1. What are the requirements for the crack to advance by R curve concept?
2. Explain J integral and Crack growth Resistance curves for ductile and brittle materials
3. Why does the Compliance of the component increases with the growth of a crack?

Course Outcome 6 (CO6):

1. Determine the energy release rate of DCB specimen through the change in strain energy approach for constant load.
2. Discuss elastic and Visco elastic behavior of steel and explain plastic deformation process of steel.
3. Draw a neat sketch of CT and SENB specimen as per ASTM Standard and explain the method of precracking in these specimens.

Concept Map



Syllabus

Introduction-Review of Engineering Failure Analysis-Brittle fracture-Ductile fracture Modes of fracture failure, The Griffith energy Balance Approach-Crack tip Plasticity-Fracture toughness **Linear elastic fracture Mechanics-**Elastic crack tip stress field Stress and displacement fields in isotropic elastic materials-Westergaard's approach (opening mode)-Plane Strain Fracture toughness (KIC) testing-Feddersen approach, Determination of R curve, Energy released rate for DCB specimen-An elastic deformation at crack tip-K_{1c} Test techniques, Various test specimens-Critical energy release rate **Elastic Plastic Fracture Mechanics-**Limitation of K approach -Approximate shape and size of the plastic zone-Effective crack length-Effect of plate thickness-Elastic plastic fracture concept-Crack tip opening displacement-Dugdale approach-Path independence, Critical J integral-Evaluation of CTOD-Relationship between CTOD, K_1 and G_1 for small scale yielding **Fatigue Crack Growth-**Fatigue crack growth to sharpen the tip, SN curve-methods to determine J_{1c}Mechanism of Fatigue, Fatigue crack propagation-Paris law-Crack closure mechanism-Residual stresses at crack tip-Retardation effect fatigue crack growth test, stress intensity factor, factors affecting stress intensity factor-Variable amplitude service loading, Interaction effects **Crack Arrest & Numerical methods** Principles of crack arrest, crack arrest in practice-R Curves, Crack resistance curve, Eutectic process Numerical Methods and Approaches in Fracture Mechanics, Direct methods to determine fracture parameters Indirect methods to determine fracture parameters

Reference Books

1. John M. Barson&Stanely T. Rolfe, "Fracture and Fatigue Control in Structure," Prentice Hall Inc, USA,1987.
2. David Broek, "Elementary Engineering Fracture Mechanics, " MartinusNijhoff Publishers, The Hague, 1982.
3. Jean Lemative& Jean Louis Chboche, "Mechanics of Solid Materials," Cambridge University Press, Cambridge,1987.
4. Gdoutos E. E., " Fracture Mechanics – An introduction," Kluwer Academic publishers, Dordrecht, 1993.
5. Knott J. F., "Fundamentals of Fracture Mechanics," John Wiley & Sons, New York 1973.
6. Suresh S., "Fatigue of Materials," Cambridge University Press, Cambridge 1991.
7. Bhushan L. Karihaloo, "Fracture Mechanics and Structural Concrete," Longman Scientific Publishers, USA, 1972.
8. Simha K. R. Y ., "Fracture Mechanics for Modern Engineering Design," University Press (India) Ltd, Hyderabad, 2001.

Course Contents and Lecture Schedule

1.0	**Introduction**	
1.1	Review of Engineering Failure Analysis	1
1.2	Brittle fracture-Ductile fracture	1
1.3	Modes of fracture failure, The Griffith energy Balance Approach	1
1.4	Crack tip Plasticity,Fracture toughness	1
2.0	**Linear Elastic Fracture Mechanics**	
2.1	Elastic crack tip stress field	1

2.2	Stress and displacement fields in isotropic elastic materials	1
2.3	Westergaard’s approach (opening mode)	1
2.4	Plane Strain Fracture toughness (KIC) testing	1
2.5	Feddersenapproach,Determination of R curve.	1
2.6	Energy released rate for DCB specimen	1
2.7	Anelastic deformation at crack tip	1
2.8	K_{1c} Test techniques, Various test specimens	1
2.9	Critical energy release rate	1
3.0	**Elastic Plastic Fracture Mechanics**	
3.1	limitation of K approach	1
3.2	Approximate shape and size of the plastic zone	1
3.3	Effective crack length	1
3.4	Effect of plate thickness	1
3.5	Elastic plastic fracture concept	1
3.6	Crack tip opening displacement	1
3.7	Dugdale approach	1
3.8	Path independence ,Critical J integral	1
3.9	Evaluation of CTOD	1
3.10	Relationship between CTOD, K_1 and G_1 for small scale yielding	1
4.0	**Fatigue Crack Growth**	
4.1	Fatigue crack growth to sharpen the tip	1
4.2	Load displacement test	1
4.3	Test methods to determine J_{1c}	1
4.4	Mechanism of Fatigue ,Fatigue crack propagation	1
4.5	Paris law, crack closure mechanism	1
4.6	Residual stresses at crack tip,Retardation effect	1
4.7	Fatigue crack growth test, stress intensity factor, factors affecting stress intensity factor	1
4.8	variable amplitude service loading, Interaction effects.	1

5.0	**Crack Arrest & Numerical methods**	
5.1	Principles of crack arrest, crack arrest in practice	1
5.2	K-R Curves, Crack resistance curve	1
5.3	Numerical Methods and Approaches in Fracture Mechanics	1
5.4	Direct methods to determine fracture parameters	1
5.5	Indirect methods to determine fracture parameters	1
	Total	**36**

Course Designers:

R.Ponnudurai rpciv@tce.edu

14CEPS0	INTRUMENTATION IN CIVIL ENGINEERING	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course deals with the various instruments that are used in civil engineering and to expose the students about the significance of measurements and applications. At the end of the course the students will be able to acquire knowledge on various types of measuring instruments used in civil Engineering, understand the principle of operation of measuring instruments, explain the operation of instruments related to static and dynamic measurements, understand the principle of operation of structural measuring instruments.

Prerequisite

Engineering Physics, Engineering mathematics, Hydraulics and Fluid Mechanics 14CE330, 14CE430

Course Outcomes

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

			Expected Attainment level (%)	Expected Proficiency level (grade)
CO1	Identify the basic forces for indicating instruments	Understand	70	A
CO2	Apply the instrument techniques for structural related problem in civil engineering	Apply	70	A
CO3	Apply seismic instruments for measuring the vibration motion in structures	Apply	70	A

Mapping with Programme Outcomes

CO4	Quantity the environmental related problems by using the various measuring instruments	Understand	70	A
CO5	Explain the principle and usage of flow meters in flow measurements	Apply	70	A
CO6	Visualize the stress variation in a body under photoelastic principles	Understand	70	A

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO23.	L	-	-	-	-	-	-	-	-	-	-	-	L	-
CO24.	S	M	-	-	-	-	-	-	-	-	-	-	M	-
CO3.	S	M	-	-	S	-	-	-	-	-	-	-	M	-
CO4.	L	-	-	-	-	S	S	-	-	M	M	-	L	M
CO5.	S	S	-	-	-	-	-	-	-	-	-	-	M	-
CO6.	L	-	-	-	-	-	-	-	-	-	-	-	L	-

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	10	10	10	10
Apply	30	30	30	30
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	50	50	50	50

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Differentiate between Active and Passive types of instrument with examples?
2. Define Range of an instrument.
3. What do you mean by calibration? And why it is necessary.
4. Distinguish between accuracy and precession.
5. What is resolution of an instrument?
6. Explain any five types of Instruments with examples?
7. Explain any five static characteristics of an Instrument?
8. Write down the different errors?

Course Outcome 2 (CO2):

1. What do you understand by the term transducer, how are they classified?
2. Why electrical transducers are more popular as secondary transducers over the mechanical type?
3. Explain the principle of operation of piezoelectric transducers. Why their use is limited to the measurement of dynamic quantities only?
4. Explain with a neat sketch the principle of working of a LVDT and sketch the input output graph. Discuss its merits and demerits.
5. Explain the physical principles involved in the operation of various tyes of inductive transducers?

Course Outcome 3 (CO3):

1. Explain with a neat sketch the principle of working of a pneumatic or hydraulic load cell for the measurement of force.
2. How are the elastic transducers used for the measurement of force? What secondary transducers are generally employed with elastic transducer?
3. What is a proving ring and why is it named so? How can it be used to measure force.
4. Explain the principle of working of load cells using strain gauges.
5. Discuss the principle of working of a seismic instrument explaining how it can be used to measure displacement velocity and acceleration
6. Explain the principle of working of a seismic instrument as an accelometer.
7. What secondary transducers are employed in these instrument?

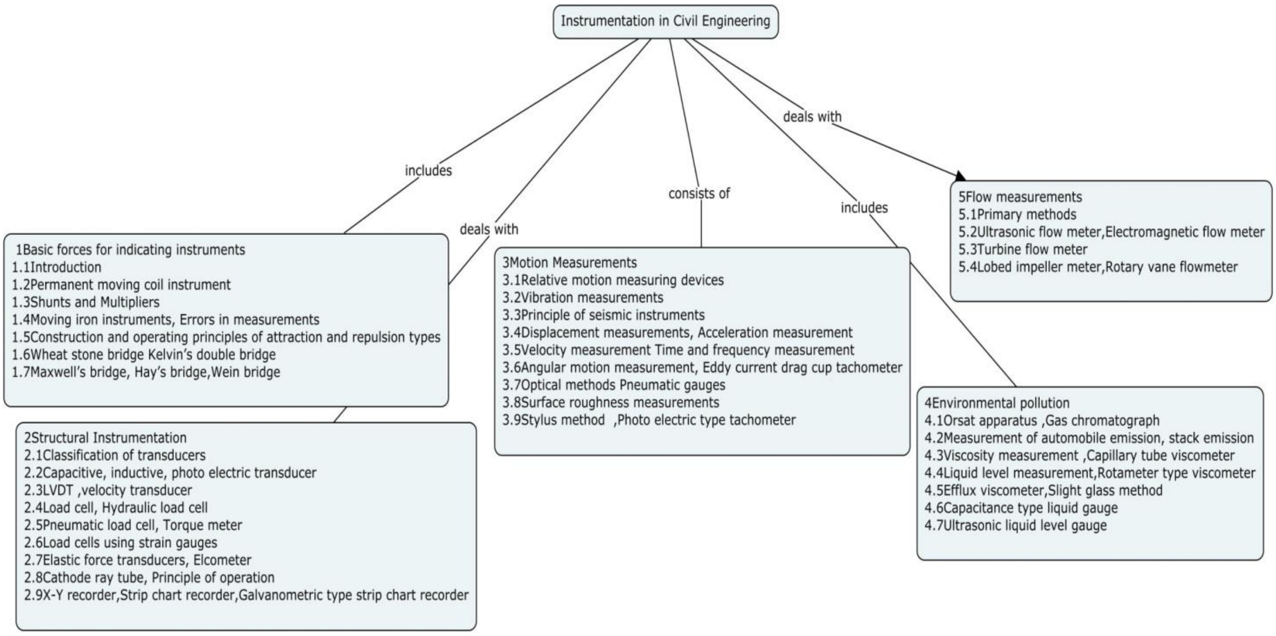
Course Outcome 4 (CO4):

1. Enumerate and explain the various methods for the measurement of velocity of flow at a point.
2. Sketch and explain the principle of working of,
   (i) Turbine flow meter
   (ii) Electromagnetic flow meter.
3. Discuss the constant current and constant temperature mode of operation.
4. How the anemometer measuring the flow of liquids differs from that used for gases.
5. Sketch and explain the principle of working of a hot wire anemometer.

Course Outcome 5 (CO5):

1. Discuss the constant current and constant temperature mode of operation.
2. How the anemometer measuring the flow of liquids differs from that used for gases.
3. Sketch and explain the principle of working of a hot wire anemometer.

Concept Map



Syllabus

Basic forces for indicating instruments-Introduction - Permanent moving coil instrument- Shunts and Multipliers - Moving iron instruments, Errors in measurements - Construction and operating principles of attraction and repulsion types - Wheat stone bridge Kelvin's double bridge - Maxwell's bridge, Hay's bridge, Wein bridge - **Structural Instrumentation** - Classification of transducers - Capacitive, inductive, photo electric transducer - LVDT ,velocity transducer - Load cell, Hydraulic load cell - Pneumatic load cell, Torque meter - Load cells using strain gauges - Elastic force transducers, Elcometer - Cathode ray tube, Principle of operation - X-Y recorder, Strip chart recorder, Galvanometric type strip chart recorder - **Motion Measurements** - Relative motion measuring devices - Vibration measurements - Principle of seismic instruments - Displacement measurements, Acceleration measurement - Velocity measurement Time and frequency measurement - Angular motion measurement, Eddy current drag cup tachometer - Optical methods Pneumatic gauges - Surface roughness measurements - Stylus method ,Photo electric type tachometer- **Environmental**

pollution- Orsat apparatus ,Gas chromatograph - Measurement of automobile emission, stack emission - Viscosity measurement ,Capillary tube viscometer - Liquid level measurement, Rotameter type viscometer - Efflux viscometer, Slight glass method - Capacitance type liquid gauge - Ultrasonic liquid level gauge- **Flow measurements**- Primary methods - Ultrasonic flow meter, Electromagnetic flow meter - Turbine flow meter - Lobed impeller meter, Rotary vane flow meter.

Reference Books

1. Keith Cheatle, "Fundamentals of Test Measurement Instrumentation", ISA publishers, 2004.
2. Michael D. Whitt, "Successful Instrumentation and Control systems design with CD", ISA publishers, 2004.
3. Jim Strothman, "ISA Handbook of Measurement Equations and Tables", 2nd Edition, ISA publishers, 2006.
4. Gregory K. McMillan and Robert A. Cameron, "Advanced pH Measurement and Control", 3rd Edition, ISA publishers, 2005.

Course Contents and Lecture Schedule

Sl No	Topics	Periods
1	**Basic forces for indicating instruments**	
1.1	Introduction	1
1.2	Permanent moving coil instrument	1
1.3	Shunts and Multipliers	1
1.4	Moving iron instruments, Errors in measurements	1
1.5	Construction and operating principles of attraction and repulsion types	1
1.6	Wheat stone bridge Kelvin's double bridge	1
1.7	Maxwell's bridge, Hay's bridge,Wein bridge	1
2	**Structural Instrumentation**	
2.1	Classification of transducers	1
2.2	Capacitive, inductive, photo electric transducer	1
2.3	LVDT ,velocity transducer	1
2.4	Load cell, Hydraulic load cell	1
2.5	Pneumatic load cell, Torque meter	1
2.6	Load cells using strain gauges	1
2.7	Elastic force transducers, Elcometer	1

2.8	Cathode ray tube, Principle of operation	1
2.9	X-Y recorder,Strip chart recorder,Galvanometric type strip chart recorder	1
3	**Motion Measurements**	
3.1	Relative motion measuring devices	1
3.2	Vibration measurements	1
3.3	Principle of seismic instruments	1
3.4	Displacement measurements, Acceleration measurement	1
3.5	Velocity measurement Time and frequency measurement	1
3.6	Angular motion measurement, Eddy current drag cup tachometer	1
3.7	Optical methods Pneumatic gauges	1
3.8	Surface roughness measurements	1
3.9	Stylus method ,Photo electric type tachometer	1
4	**Environmental pollution**	
4.1	Orsat apparatus ,Gas chromatograph	1
4.2	Measurement of automobile emission, stack emission	1
4.3	Viscosity measurement ,Capillary tube viscometer	1
4.4	Liquid level measurement,Rotameter type viscometer	1
4.5	Efflux viscometer,Slight glass method	1
4.6	Capacitance type liquid gauge	1
4.7	Ultrasonic liquid level gauge	1
5	**Flow measurements**	
5.1	Primary methods	1
5.2	Ultrasonic flow meter,Electromagnetic flow meter	1
5.3	Turbine flow meter	1
5.4	Lobed impeller meter,Rotary vane flowmeter	1
	Total	**36**

Course Designers:

Dr. R.Ponnudurai rpdciv@tce.edu

14CEPT0	REINFORCED CONCRETE DESIGN	Category	L	T	P	Credit
		PC	2	2	0	3

Preamble

The extensive use of reinforced concrete for a variety of structural members has necessitated a proper understanding of the design in structural concrete members by the structural engineers. This course offers analysis and design of reinforced concrete structures like deep beams, corbels, curved beams, shear wall, bunkers and silos, virendeel girders, poles, pipes, formworks and concrete trusses as per IS specifications. It also aims at determination of safe as well as economical sections and their reinforcement under various types of loading. At the end of the course, student has a comprehensive design knowledge related to structures and systems that are likely to be encountered in professional practice.

Prerequisites

Knowledge of Mathematics, Strength of Materials 14CE220, Structural Analysis 14CE420, and Design of reinforced concrete elements 14CE610

Course Outcomes

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

			Expected Attainment level (%)	Expected Proficiency level(grade)
CO1	Design special elements such as deep beams, corbels and curved beams	Apply	70	A
CO2	Design special elements such as shear wall and bunkers and silos	Apply	70	A
CO3	Design special elements such as Virender girders and poles	Apply	70	A
CO4	Design reinforced concrete pipes under various types of loading	Apply	70	A
CO5	Design formworks for column, beam and floor slab	Apply	70	A
CO6	Analyse and design the concrete trusses	Apply	70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO66	S	M	S	-	-	-	M	M	M	S	-	-	M	-
CO67	S	M	S	-	-	-	M	M	M	S	-	-	M	-
CO68	S	M	S	-	-	-	M	M	M	S	-	-	M	-
CO69	S	M	S	-	-	-	M	M	M	S	-	-	M	-
CO70	S	M	S	-	-	-	M	M	M	S	-	-	M	-
CO71	S	M	S	-	-	-	M	M	M	S	-	-	M	-

S- Strong; M-Medium; L-Low

Assessment Pattern:

Assessment	Test – I	Test – II	Test – III	End Semester

Remember	10	10	10	10
Understand	10	10	10	10
Apply	80	80	80	80
Analysis	--	--	--	--
Evaluate	--	--	--	--
Create	--	--	--	--
Total	100	100	100	100

Course Level Assessment Questions

CO1: Design special elements such as deep beams, corbels, curved beams, shear wall, bunkers and silos, virendeel girders and poles

1. Define the term: Deep beam.
2. Draw the reinforcement detailing of corbel.
3. What are the differences between bunkers and silos?
4. What are the different methods adopted for the analysis of virendeel girders?
5. Compute reinforcement required for a beam of size 350mm x 550mm circular in plan subjected to a bending moment of 140kNm, twisting moment of 18kNm and a shear force of 90kN under ultimate condition. Use M25 grade concrete and Fe415 as materials. Draw the reinforcement details also.
6. A plain traced concrete wall of dimensions 8 m high, 6 m long and 200 mm thick is restrained against rotation at its base and unrestrained at the ends. If it has to carry a factored total gravity load of 200 kN and a factored horizontal load of 8 kN at top. Check the safety of the wall. Assume M25 and Fe500. Draw the reinforcement details.
7. Analyse and Design a corbel for a 350mm square column to support an ultimate vertical load of 600kN with its Line of action 200mm from the face of the column. Use M20 grade concrete and Fe 415 grade steel. Sketch the reinforcement details.
8. Make use of limit state method; design a circular cylindrical bunker to store 20 tonnes of coal. Density of coal is 9 kN/m^3. Angle of repose is 30 degrees. Use M20 and Fe415 as materials. Sketch the reinforcement details of bunker.
9. A virendeel girder of 9m has 3 bays of 3m each. The height of the verticals is 3m. The girder supports concentrated loads of 100 kN and 50 kN at the interior node points of the top dome. Assuming constant stiffness for the members, compute the moments forces in the girder.
10. A reinforced concrete pole 10m long is required to carry 4 conductors of 7mm diameter each spaced at 500mm intervals in a cross arm fixed at 600mm from the top. The depth of embedment is 1.8m, below ground level. Spacing of poles is 50m. Wind pressure is 1.5 kN/m^2. Load factor is 2.5. Tension in conduction is 3 kN. Make use of M20 and Fe415 as materials design suitable pole for the transmission line.

CO2: Design reinforced concrete pipes under various types of loading

1. What are the classifications of pipes?
2. Explain the design principles of pipes.
3. A reinforced concrete pressure pipe is to be designed to with stand a working pressure of 0.2 kN/m^2. The internal diameter of the pipe is 1000mm and the length of the pipe is 3m. Make use of M20 and hard drawn steel wire conforming to IS 432 as materials design the pipe and sketch the details of reinforcements.
4. A RCC pipe is required to withstand 15m head of water. Make use of M20 and hard drawn steel wire conforming to IS 432 as materials design the pipe and sketch the details of reinforcements.

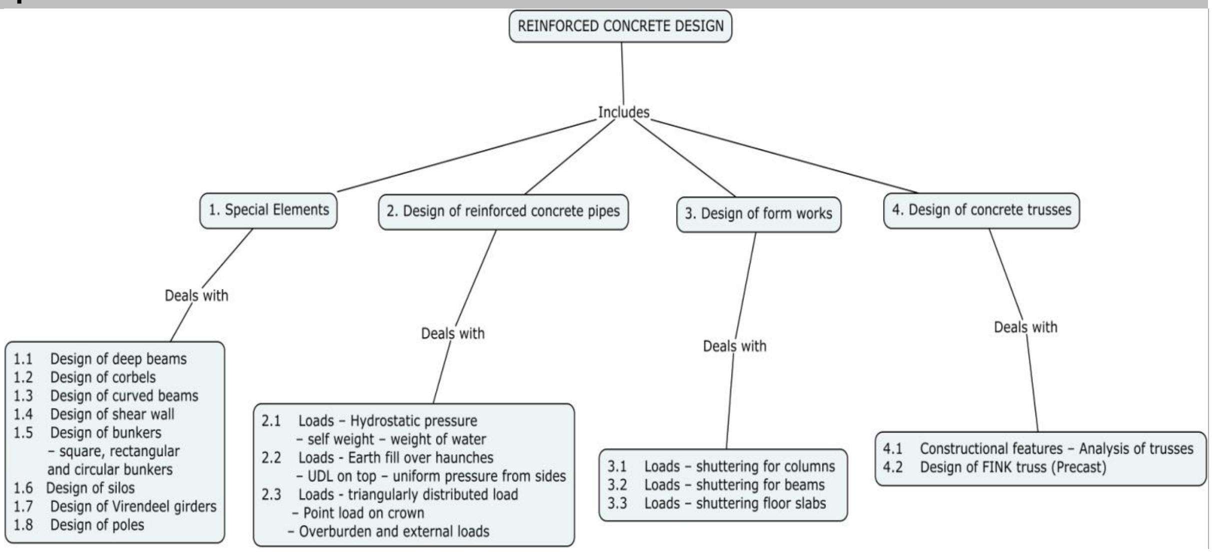
CO3: Design formworks for column, beam and floor slab

1. Draw the cross section and sectional elevation of formworks for column and beam and slab and its shuttering details.
2. Make use of IS codal provisions, design the formwork for the slab floor only for the following data: Thickness of floor = 125mm; Centre to centre spacing of beams = 3.5m; Width of beam = 250mm; Take a live load on sheathing = 3 kN/m^2; weight of wet concrete as 28.5 kN/m^3.
3. Make use of IS codal provisions, design the formwork for a column 230mm x 230mm, having a height of 1.2. It is proposed to pour the entire concrete in one stage.
4. Make use of IS codal provisions, design the formwork for the beam and slab floor for the following data: Thickness of floor = 125mm; Centre to centre spacing of beams=3.0m; Width of beam = 230mm and depth of beam is 450mm below slab; Height of ceiling of the roof is 4m above the floor; Take a live load on sheathing = 4 kN/m^2; Weight of wet concrete as 28.5 kN/m^3.

CO4: Analyse and design concrete trusses

1. Draw the cross section of various types of concrete trusses.
2. Explain the analysis of trusses.
3. Make use of M20 and Fe415 as materials; design a reinforced concrete fink type truss to suit the following data. Span of truss: 25m. Spacing of trusses: 5m. Central rise of truss: 4.13m. It is used to support concrete purlins at intervals of 1.35m and asbestos sheets cover roof. Sketch the details of reinforcement details of members of truss.

Concept Map



Syllabus

Special Elements - Design of deep beams – Design of corbels - Design of curved beams - Design of shear wall - Design of bunkers – square, rectangular and circular bunkers – Design of silos - Design of Virendeel girders - Design of poles. **Design of reinforced concrete pipes** - Loads – Hydrostatic pressure – self weight – weight of water – earth fill over haunches – UDL on top – uniform pressure from sides – triangularly distributed load – Point load on crown – Overburden and external loads. **Design of form works** – Loads – shuttering for columns, beams and floor slabs. **Design of concrete trusses** – Constructional features – Analysis of trusses – Design of FINK truss (Precast)

Text Books

1. N. Krishna Raju Advanced Reinforced Concrete Design IS 456-2000, CBS Publishers and Distributors, New Delhi, 2010.
2. P.C. Varghese, Advanced Reinforced Concrete Design, Prentice Hall of India, Pvt. Ltd., New Delhi, 2013.

Reference Books

1. M.L. Gambhir, Design of Reinforced Concrete structures, Prentice Hall of India Private limited, New Delhi, 2012.
2. N. Subramanian, Design of Reinforced Concrete Structures, Oxford University Press, New Delhi, 2014.
3. B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, RCC Designs (Reinforced Concrete Structures), Laxmi Publications Pvt. Ltd., New Delhi, 2015.
4. S.N. Sinha, Reinforced Concrete Design, Tata McGraw-Hill, New Delhi, 2002.
5. I.C.Syal and A.K.Goel, "Reinforced Concrete Structures", S.Chand and Company Ltd, New Delhi, 2012.
6. Self learning materials – online courses - http://nptel.ac.in/courses/ 105105104/20

IS Codes

1. IS 456:2000 Plain and Reinforced Concrete – Code of Practice.
2. IS 875(1-5): 1987 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures.
3. IS 485: 2003 Precast concrete pipes (with and without reinforcement) – Specification
4. IS 783: 1985 Code of practice for laying of concrete pipes
5. IS 3201: 1988 Criteria for design and construction of precast concrete trusses and purlins
6. IS 4995: 1974 Criteria for design of reinforced concrete bins for the storage of granular and powdery materials
   a. Part I: General requirements and assessment of bin loads
   b. Part II: Design Criteria
7. IS 785: 1998 Reinforced concrete poles for overhead tower and telecommunication lines – Specification.
8. SP 16:1980 Design Aids for Reinforced Concrete to IS 456:1978.
9. SP 34:1987 Handbook of concrete reinforcement and detailing.

Course Contents and Lecture Schedule

Module No.	Topics	No of Lectures
1.0	**Special Elements**	
1.1	Design of deep beams	2
1.2	Design of corbels	2
	Tutorial – Design problem	2
	Tutorial – Reinforcement Detailing of deep beam and corbel	1
1.3	Design of curved beams	1
1.4	Design of shear wall	1
	Tutorial – Design problem	2
	Tutorial – Reinforcement Detailing of curved beam and shear wall	1
1.5	Design of bunkers – square, rectangular and circular bunkers	2
1.6	Design of silos	2

	Tutorial – Design problem	2
	Tutorial – Reinforcement Detailing of bunkers and silo	1
1.7	Design of Virendeel girders	2
1.8	Design of poles	2
	Tutorial – Design problem	2
	Tutorial – Reinforcement Detailing of virendeel girder and pole	1
2.0	**Design of reinforced concrete pipes**	
2.1	Loads – Hydrostatic pressure – self weight – weight of water	1
	Tutorial – Design problem	1
	Tutorial – Reinforcement Detailing of pipes	1
2.2	Loads - Earth fill over haunches – UDL on top – uniform pressure from sides	1
	Tutorial – Design problem	1
	Tutorial – Reinforcement Detailing of pipes	1
2.3	Loads - triangularly distributed load – Point load on crown – Overburden and external loads	1
	Tutorial – Design problem	1
	Tutorial – Reinforcement Detailing of pipes	1
3.0	**Design of form works**	
3.1	Loads – shuttering for columns	1
3.2	Loads – shuttering for beams	1
3.3	Loads – shuttering floor slabs	1
	Tutorial – Design problem	3
	Tutorial – Detailing of shuttering for column, beam and slab	1
4.0	**Design of concrete trusses**	
4.1	Constructional features – Analysis of trusses	1
4.2	Design of FINK truss (Precast)	2
	Tutorial – Design problem	2
	Tutorial - Reinforcement Detailing of truss	1
	TOTAL	**48**

Course Designers

Dr. K. Arunachalam	karcivil@tce.edu
Dr. M.C. Sundarraja	mcsciv@tce.edu
Mr. D. Rajkumar	rajkumarcivil@tce.edu

14CEPU0	GROUND WATER MANAGEMENT	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

An objective is to develop an overall comprehension of principles, methods and practices of well hydraulics and concept of ground water management. Need for protecting ground water resource from contamination. Planning of groundwater development under various conditions and constraints.

Prerequisite

Nil

Course Outcomes

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

			Expected Attainment level(%)	Expected Proficiency level(grade)
CO1	Explain the origin and occurrence of ground water	Understand	70	A
CO2	Explain the properties and types of aquifers	Understand	70	A
CO3	Plan and develop ground water resources	Apply	70	A
CO4	Develop control techniques for ground water pollution hazards	Apply	70	A
CO5	Calculate the yield from pumping test data	Apply	70	A
CO6	Practice artificial Recharge of ground water	Apply	70	A

Mapping with Programme Outcomes

COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	L	-	-	L	S	-	S	-	-	-	L	L
CO2	M	M	L	-	-	L	L	-	M	-	-	-	L	M
CO3	S	M	L	-	-	M	M	M	L	-	-	-	M	M
CO4	S	M	L	-	-	M	L	-		-	-	-	M	L

CO5	S	L	L	-	-	M	S	S	M	-	-	-	L	M
CO6	S	L	M	-	-	M	S	S	M	-	-		L	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	20	20	20	40
Apply	60	60	60	40
Analyze	--	--	--	--
Evaluate	--	--	--	--
Create	--	--	--	--

Course Level Assessment Question

CO1: Understand the origin occurrence of ground water

1. Define aquifer.
2. Derive an expression for the steady state discharge of well fully penetrating into a confined aquifer.
3. In a water table aquifer of 50m thickness, a 20cm diameter well is pumped at a uniform rate of 0.05m^3/s. If the steady state drawdown measured in the observation wells located at 10m and 100m distances from the well are 6.5m and 0.25m respectively, determine the hydraulic conductivity of the aquifer.

CO2: Plan and development of the ground water resources

1. Explain the term utilizable recharge.
2. Explain the various practices followed in india for the development of ground water resources.
3. A Sample has a hydraulic conductivity of 15m per day what would be its intrinsic permeability. Estimate its hydraulic conductivity at 30^{o} C.

CO3: Control of Ground Water Pollution Hazards

1. Define the term pollution hazard in ground water.
2. List out the advantages of ground water compared to surface water?
3. How do you apply the various methods to control pollution hazards in ground water?

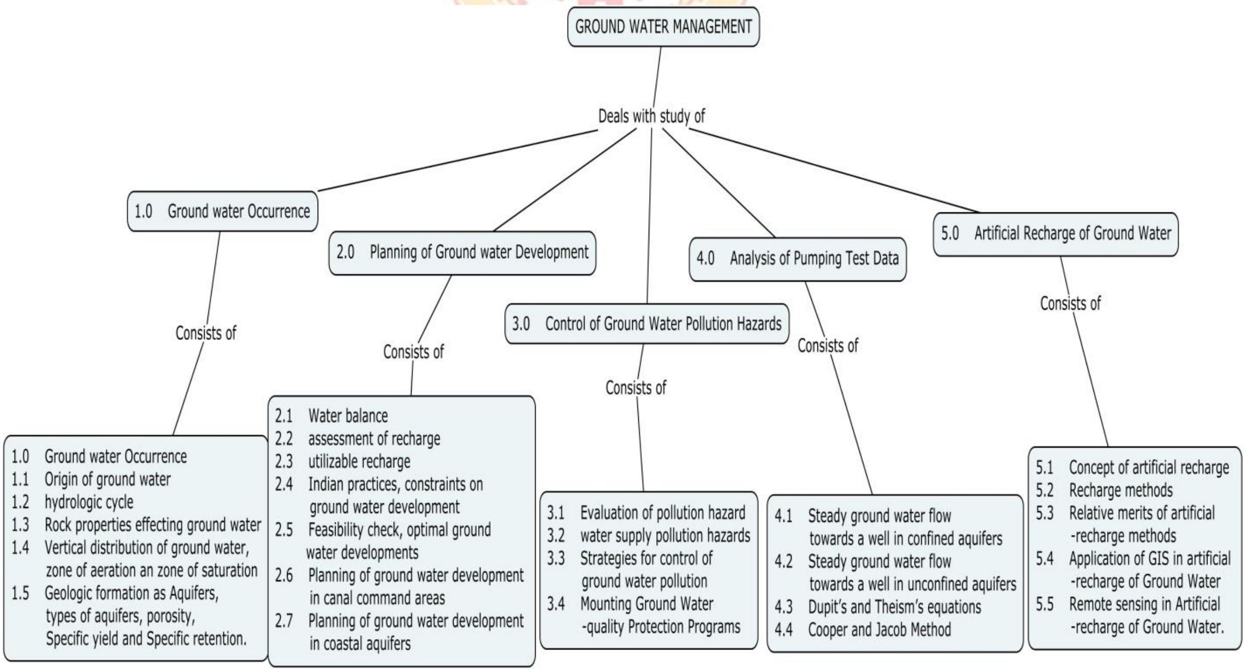
CO4: Analysis of Pumping Test Data

1. List out the advantages of pumping test?
2. A 20cm diameter well penetrates fully a confined aquifer of thickness 25m. When the well is pumped at a rate of 200litres per minute the steady state draw down in the two observations wells located at 10m and 100m distance from the pumping well are found to be 3.5m and 0.05m respectively. Calculate the permeability and transmissivity of the aquifer.
3. Determine the yield from a 30cm diameter well under a draw down of 10m in the well, if the radius of influence and hydraulic conductivity are 150m and 5m per day respectively. The aquifer is unconfined with a thickness of 60m.

CO5: Artificial Recharge of Ground Water

1. List out the advantages of artificial recharge?
2. Explain the various methods of Artificial Recharge of Ground water.
3. How do apply Remote sensing and GIS for augmentation of ground water storage.

Concept Map



Syllabus

Ground water Occurrence: Origin of ground water, hydrologic cycle, rock properties effecting ground water, vertical distribution of ground water, zone of aeration an zone of saturation, geologic formation as Aquifers, types of aquifers, porosity, Specific yield and Specific retention. **Planning of Ground water Development:** Water balance, assessment of recharge, utilizable recharge, Indian practices, constraints on ground water development, feasibility check, optimal ground water developments, planning of ground water development in canal command areas, planning of ground water development in coastal aquifers. **Control of Ground Water Pollution Hazards:** Evaluation of pollution hazard and water supply pollution hazards. Strategies for control of ground water pollution. Mounting Ground Water Quality Protection Programs. **Analysis of Pumping Test Data:** Steady ground water flow towards a well in confined and unconfined aquifers, Dupit's and Theism's equations, Cooper and Jacob Method. **Artificial Recharge of Ground Water:** Concept of artificial recharge, Recharge methods, Relative merits, Application of GIS and Remote sensing in Artificial Recharge of Ground Water.

Text Book

1. Ground water Hydrology by David Keith Todd,John Wiley &son, New York,Third revised edition(2005)
2. Groundwater by H.M.Raghunath,Wiley Eastern Ltd.(1 December 2007)

Reference Books

1. Groundwater by Bawvwr, John Wiley & sons.
2. Groundwater system planning & management- R.Willies & W.W.G.Yeh,Printice Hall.
3. Apply hydrogeology by C.W.Fetta, CBS Publishers & Distributers

Course Content and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	**Ground water Occurrence**	
1.1	Origin of ground water	1
1.2	hydrologic cycle	1
1.3	Rock properties effecting ground water	1
1.4	Vertical distribution of ground water, zone of aeration an zone of saturation	1
1.5	Geologic formation as Aquifers, types of aquifers, porosity, Specific yield and Specific retention.	2
2.0	**Planning of Ground water Development**	
2.1	Water balance	1
2.2	assessment of recharge	1
2.3	utilizable recharge	1
2.4	Indian practices, constraints on ground water development	1
2.5	Feasibility check, optimal ground water developments	1
2.6	Planning of ground water development in canal command areas	2
2.7	Planning of ground water development in coastal aquifers	1
3.0	**Control of Ground Water Pollution Hazards**	
3.1	Evaluation of pollution hazard	2
3.2	water supply pollution hazards	1
3.3	Strategies for control of ground water pollution	1
3.4	Mounting Ground Water Quality Protection Programs	1
4.0	**Analysis of Pumping Test Data**	
4.1	Steady ground water flow towards a well in confined aquifers	2
4.2	Steady ground water flow towards a well in unconfined aquifers	2
4.3	Dupit's and Theism's equations	2
4.4	Cooper and Jacob Method	2
5.0	**Artificial Recharge of Ground Water**	

5.1	Concept of artificial recharge	1
5.2	Recharge methods	1
5.3	Relative merits of artificial recharge methods	1
5.4	Application of GIS in artificial recharge of Ground Water	3
5.5	Remote sensing in Artificial Recharge of Ground Water.	3
	TOTAL	**36**

Course Designers:

Mr.M.Ramasamy mrciv@tce.edu
Dr. S.Chandran schandran@tce.edu

14CEPV0	PREFABRICATED STRUCTURES	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

Prefabricated construction is a building process in which elements or modules of the structure are prefabricated at plants, and then transported to the construction site for installation. Using this method it reduces the time of building also saves construction cost. Prefabricated construction is now widely applied for new houses or other building structures like bridge, tunnels, culverts, water supply system. These structures are easy to erect as it is light material. These types of prefabricated buildings were constructed in earthquake prone areas. This course imparts knowledge on modular construction, industrialized construction and design of prefabricated elements and construction methods.

Prerequisite

Nil

Course Outcomes

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

			Expected Attainment level(%)	Expected Proficiency level(grade)
CO1	Enumerate the details of production, transportation and erection of prefabrication systems	Understand	70	A
CO2	Demonstrate the behaviour and construction sequence of prefabricated slabs, walls and columns	Apply		
CO3	Design the economical cross section of prefabricated structures	Apply	70	A
CO4	Discuss the joints in precast buildings with construction sequence	Apply	70	A
			70	A
CO5	Explain the progressive collapse and its codal provisions in prefabricated system	Apply		
			70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO25.	S	M	L	L	-	-		L	L	L	M	-	L	L
CO26.	S	S	M	L	-	-		L	L	L	M	-	L	L

CO3.	S	S	S	S	-	L		L	L	L	M	-	L	L
CO4.	S	S	M	M	-	-		L	L	L	M	-	L	L
CO5.	S	M	M	M	-	-		L	L	L	M	-	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	**20**	**20**	**20**	**20**
Understand	**20**	**20**	**20**	**20**
Apply	**60**	**60**	**60**	**60**
Analyse	**-**	**-**	**-**	**-**
Evaluate	**-**	**-**	**-**	**-**
Create	**-**	**-**	**-**	**-**

Course Level Assessment Questions

Course Outcome 1 (CO1):

83. **Mention the need and advantages of using precast technology.**
84. **Define the term modular co-ordination mentioning its purpose.**
85. **Discuss the precautions to be taken while erection of precast elements.**

Course Outcome 2 (CO2):

4. Give dimensional tolerance details for cross sectional dimension.
5. Explain the various types of roof and floor panels.
6. Explain the term lift-slab construction.
7. What are the loads acting of wall panels?

Course Outcome 3 (CO3):

1. How does the material used in construction affect the design of the element?
2. Distinguish between rigid joint and hinged joint with reference to prefabricated construction?
3. Explain the problems involved in design because of joint flexibility. Discuss with regard to various locations.
4. What are the precautions taken during disuniting of structures?

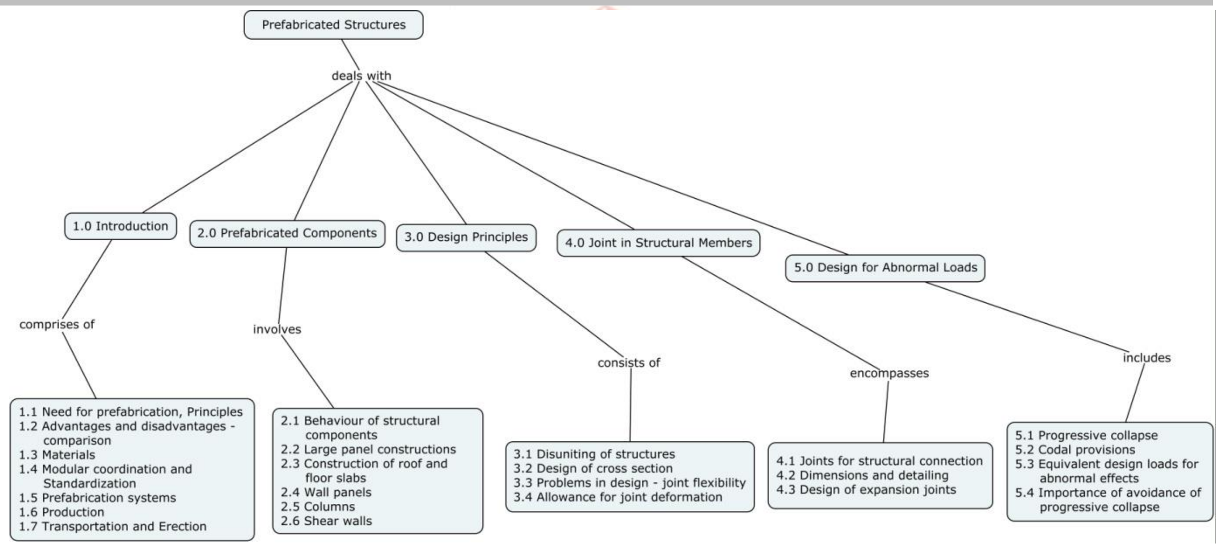
Course Outcome 4 (CO4):

1. What is the importance of joints in precast structures when compared to cast- in-situ structures?
2. Mention the need for expansion joint in precast structures.
3. Explain in detail the different structural connection adopted in a framed precast building with sketches.
4. Give the guidelines recommended for expansion joint design and location.

Course Outcome 5 (CO5):

1. What are the approaches to avoid progressive collapse?
2. What are provisions made in a Prefabricated R C floors in a cyclone prone zone?
3. When a progressive collapse does occur? Why is it very critical to avoid progressive collapse of structures?
4. Explain the procedure for calculating equivalent design loads when the structure is subjected to earthquake loading

Concept Map



Syllabus

Introduction: Need for prefabrication – Principles - advantages and disadvantages-comparison of precast construction method and in-situ method – Materials – Modular coordination – Standardization - Systems – Production – Transportation – Erection **Prefabricated Components:** Behaviour of structural components – Large panel constructions – Construction of roof and floor slabs – Wall panels – Columns – Shear walls **Design Principles:** Disuniting of structures - Design of cross section based on efficiency of material used – Problems in design because of joint flexibility – Allowance for joint deformation **Joint in Structural Members:** Joints for different structural connections – Dimensions and detailing – Design of expansion joints **Design for Abnormal Loads:** Progressive collapse – Code provisions – Equivalent design loads for considering abnormal effects such as earthquakes, cyclones, etc., - Importance of avoidance of progressive collapse.

Text Books

1. CBRI, Building materials and components, India, 1990

2. Gerostiza C.Z., Hendrikson C. and Rehat D.R., "Knowledge based process planning for construction and manufacturing", Academic Press Inc., 1994

Reference Books

5. Koncz T., "Manual of precast concrete construction", Vol. I, II and III, Bauverlag, GMBH, 1976.
6. "Structural design manual", Precast concrete connection details, Society for the studies in the use of precast concrete, Netherland Betor Verlag, 2009.

List of National and International Standards

1. IS: 15916 -2011, Building Design and Erection using Prefabricated Concrete – Code of Practice
2. IS 11447:1985 - Code of practice for construction with large panel prefabricates
3. American Society of Civil Engineers, Reston, V "Minimum Design Loads for Buildings and Other Structures,2002 edition" ASCE 7-02, 2002.
4. ACI 318, "Building Code Requirements for Structural Concrete and Commentary, ACI 318-02" American Concrete Institute.
5. General Services Administration "Progressive Collapse Analysis and Design Guidelines for New Federal Office" GSA 2003b

Course Contents and Lecture Schedule

S.NO	TOPICS	No. of Lectures
1	**Introduction**	
1.1	Need for prefabrication, principles, process and uses of prefabrication	1
1.2	Advantages and disadvantages of prefabrication, comparison of precast construction method and in situ method	1
1.3	Materials used and its characteristics	1
1.4	Modular coordination and Standardization	2
1.5	Prefabrication systems	2
1.6	Production	1
1.7	Transportation and Erection	2
2	**Prefabricated Components**	
2.1	Behaviour of structural components	2
2.2	Large panel constructions	1
2.3	Construction of roof and floor slabs	2
2.4	Wall panels	2
2.5	Columns	1

2.6	Shear walls	1
3	**Design Principles**	
3.1	Disuniting of structures	2
3.2	Design of cross section based on efficiency of material used	2
3.3	Problems in design because of joint flexibility	1
3.4	Allowance for joint deformation	1
4	**Joint in Structural Members**	
4.1	Joints for different structural connections	2
4.2	Dimensions and detailing	2
4.3	Design of expansion joints	1
5	**Design for Abnormal Loads:**	
5.1	Progressive collapse	2
5.2	Codal provisions in ASCE, ACI and GSA	2
5.3	Equivalent design loads for considering abnormal effects such as earthquakes, cyclones, etc.,	1
5.4	Importance of avoidance of progressive collapse	1
	Total Hours	**36**

Course Designers:

1. Dr.B.Sivagurunathan sivagurunathan@tce.edu
2. Ms.M.Vigneshwari mvigneshwari@tce.edu

		Category	L	T	P	Credit
14CEPW0	**WASTE MANAGEMENT**	PE	3	0	0	3

Preamble

This course provides an in-depth knowledge of various types of waste, its characteristics, technology and management for the safe disposal of waste generated by a community.

Course Outcomes

			Expected Attainment Level (%)	Expected Proficiency Level (grade)
CO1	Illustrate the status ,environmental challanges in Waste Management .	Apply	70	A
CO2	Apply the various processing technologies for various types of wastes.	Apply	70	A
CO3	Analyze the economical aspects of waste management	Apply	70	A
CO4	Adopt the suitable approach for effective waste management	Apply	70	A
CO5	Evaluate the best practices in waste management	Apply	70	A
CO6	Suggest appropriate options for the safe disposal of waste	Apply	70	A

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

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO27.	M	M	-	-	-	L	M	L	-	L	-	-	L	L
CO28.	S	M	S	M	-	M	M	-	-	-	-	-	M	L
CO3	M	M	M	-	-	M	M	-	-	M	-	S	L	M
CO4	L	M	M	M	-	L	S	-	-	L	-	-	M	L
CO5	M	M	L	S	-	S	S	-	S	M	-	M	M	M
CO6	M	M	S	S	-	S	S	S	S	M	-	S	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	40	40	40	40
Apply	40	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

86. **List the characteristics of Hazardous Waste.**
87. **List the essential functional elements in Municipal Solid Waste Management.**
88. **Explain the economical aspects of Waste Management?**

Course Outcome 2 (CO2)

89. **Assess the techno-economic viability of various processing techniques for plastic waste .**
90. **Compare the environmental effects of composting and bio-gasification.**
91. **Assess the energy generation potential of Municipal Solid Waste.**

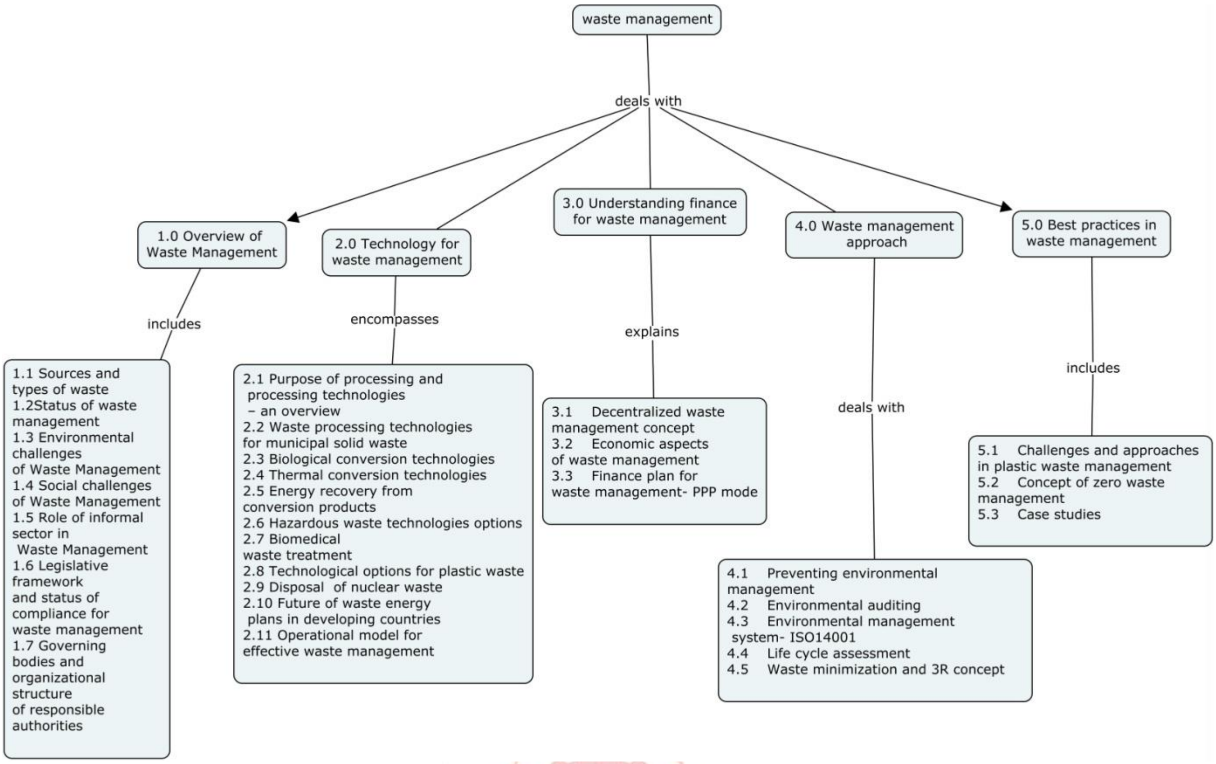
Course Outcome 3 (CO3)

4. **Discuss the benefits of Environmental Auditing**
5. Environmental management system is a step towards effective management-Justify this statement.
6. **Explore any three possible ways to reduce the waste at source in daily life .**

Course Outcome 4 (CO4)

4. Suggest the best disposal option for the hazardous waste generated from your locality.
5. Discuss the various issues faced by municipal authorities in identifying the disposal site.
6. Do you think a sanitary landfill is possible to manage wastes in your locality? List at least three reasons to support your answer.

Concept Map



Syllabus

Overview of Waste Management : Sources and types of waste; Status of waste management; Environmental and challenges of Waste Management; Role of informal sector Legislative framework; Governing bodies and organizational structure of responsible authorities.

Technology for waste management: processing technologies,;; Biological and thermal conversion technologies; Energy recovery from conversion products; Hazardous waste Biomedical waste and plastic waste treatment; Disposal of nuclear waste.

Understanding finance for waste management: Decentralized waste management concept; Economic aspects of waste management; Finance plan for waste management- PPP model-case studies.

Waste management approach: Preventing environmental management; Environmental auditing; Environmental management system- ISO14001; Life cycle assessment; Waste minimization and 3R concept.

Best practices in waste management: Challenges and approaches in plastic waste management; Concept of zero waste management; Case studies.

Text Book

3. George Tchobanoglous, Hilary Thiesen and Samuel A Vigil, “Integrated Solid Waste Management: Engineering Principles and Management Issues”, McGraw Hill Publishers, New York, 1993.

Reference Books

43. “Manual on Municipal Solid Waste Management”, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2016.
44. Bhide, A. D. and Sundaresan, B. B. “Solid Waste Management Collection, Processing and Disposal”, ISBN 81-7525-282-0, 2001.
45. Paul T Williams, “Waste Treatment and Disposal”, John Wiley and Sons, England, 2005.

Course Contents and Lecture Schedule

S. No	Topics	Periods
	1.0 Overview of Waste Management	
1.1	Sources and types of waste	2
1.2	Status of waste management-an overview.	1
1.3	Environmental and Social challenges of Waste Management - case studies	2
1.4	Role of informal sector in Waste Management	1
1.5	Legislative framework and status of compliance for waste management	2
1.6	Governing bodies and organizational structure of responsible authorities	1
	2.0 Technology for waste management	
2.1	Purpose of processing and processing technologies – an overview	1
2.2	Waste processing technologies for municipal solid waste	1
2.3	Biological conversion technologies	2
2.4	Thermal conversion technologies	1
2.5	Energy recovery from conversion products	2
2.6	Hazardous waste technologies options	1
2.7	Biomedical waste treatment	1
2.8	Technological options for plastic waste	1
2.9	Disposal of nuclear waste	1
2.10	Future of waste energy plans in developing countries	1
2.11	Operational model for effective waste management	1
	3.0 Financial aspects for waste management	
3.1	Economic aspects of waste management	1

3.2	Finance model for waste management-	1
3.3	PPP mode- Case studies	1
4.0 Waste management approach		
4.1	Preventing environmental management	1
4.2	Environmental auditing	1
4.3	Environmental management system- ISO14001	1
4.4	Life cycle assessment	1
4.5	Waste minimization and 3R concept	1
5.0 Best practices in waste management		
5.1	Decentralized waste management concept	1
5.2	Challenges and approaches in plastic waste management	1
5.3	Concept of zero waste – Case studies.	1
5.4	Case studies in different engineering disciplines	1
	TOTAL	**36**

Course Designers:

4. Dr. S.Chandran schandran@tce.edu
5. Mr. V. Ravi Sankar environmentengr@tce.edu

14CERA0	ASEISMIC DESIGN OF STRUCTURES	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course offers design of structures subjected seismic forces. This also includes Design concepts of seismic analysis and application using ETABS.

Prerequisite

Knowledge on Structural Dynamics and Design of RC Elements 14CE610 and Design of Steel Structures 14CE670, Design of RC Structures 14CE770

Course Outcomes

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

			Expected attainment level(%)	Expected proficiency level(grade)
CO1	Able to determine the seismic hazard parameters	Understand	70	A
CO2	Able to calculate the effect and response on the structure	Apply	70	A
CO3	Able to compresence the Indian codal provisions and interpret the suitable application of codal provisions.	Understand	70	A
CO4	Able to do capacity design of RC structures	Apply	70	A
CO5	Able to identify suitable configuration, Loads and do push over analysis for Steel structures.	Apply	70	A
CO6	Able to do analysis and design using ETABS	Apply	70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO_1	PSO_2
CO29.	S	M	S	M	-	L	-	-	-	-	-	-	M	M
CO30.	S	S	S	M	-	L	-	-	-	-	-	-	M	M
CO3.	S	M	S	M	-	L	-	L	-	-	-	-	L	L

CO4.	S	S	S	M	-	L	-	L	-	-	-	-	L	M
CO5.	M	S	S	M	-	L	-	L	-	-	-	-	M	L
CO6.	M	S	S	M	S	L	-	L	-	-	-	-	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	10	10	10	10
Apply	30	30	30	30
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	50	50	50	50

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Distinguish the magnitude and intensity of earthquake
2. Describe the two approaches followed for the prediction of earthquakes.
3. Name the major plates of the earth.

Course Outcome 2 (CO2):

1. Define storey drift.
2. Define 'torsional effect' on buildings?
3. Define modal mass and modal participation factor.

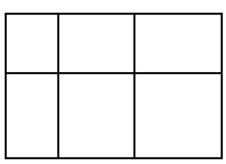
Course Outcome 3 (CO3):

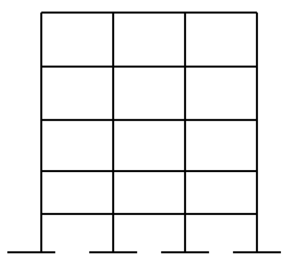
1. Explain the concepts and types of Response spectrum. Write step by step procedure of constructing response spectrum diagrams with neat sketch.
2. Design fig 1.a & 1.b by using Response spectrum method. The Free Vibration Properties of the building for vibration in the X-Direction is shown below

3 x 3@6.5m

Beam size 25 x 35 mm

Column size 30 x 40mm





Slab thickness 18mm ~~5@25m~~

Wall thickness 15mm

Fig.1.a PLAN

Fig.1.b ELEVATION

	Mode 1	Mode 2	Mode 3
Natural Period (sec) T	0.765	0.321	0.135
Mode Shape			
Roof	1.000	1.000	1.000
3rd Floor	0.924	0.185	-0.731
2nd Floor	0.786	-0.608	-0.528
1st Floor	0.441	-0.921	1.016

Course Outcome 4 (CO4):

1. Explain the factors affecting ductility of RCC members.
2. Analyse a three storied RC building by static method and also determine modal mass and modal participation factor as per IS 1893 (PART 1): 2002 for the following data.

   Seismic zone = IV

   Floor height = 4.0m

   Length of building = 10m

   Infill wall = 250mm thick in longitudinal and 150mmmm in transverse direction.

   Imposed load = 3.5 kN/m^2

   Size of columns = 250mm x 400mm.

   Size of beams = 300mm x 400mm in longitudinal and 300mm x 350mm in transverse direction

   Depth of slab = 120mm .

3. Design for lintel and Roof band of a single room building of size 6.m x 4m. The walls are 200mm thick in modular bricks built in 1:5 cement sand mortar. The height of building up to lintel level is 3m and the vertical distance between the roof band and lintel band is 1.5m.The roof band weighs 750 kg/ m2. The bands are required for a design earthquake coefficient of 0.12. Weight of wall is 450 kg/ m2 .Weight of masonry is 1900 kg/ m2.

Course Outcome 5 (CO5):

1. Analyse a three storied steel frame by static method and also determine modal mass and modal participation factor as per IS 1893 (PART 1): 2002 for the following data.

   Seismic zone = IV

   Floor height = 4.0m

   Length of building = 10m

   Imposed load = 3.5 kN/m^2

   Size of columns = ISMB 600.

   Size of beams = ISMB 300

   Chequered type of flooring of thickness 6mm.

2. Explain the impact of bracings in steel frame subjected to seismic forces
3. Discuss the behaviour of beam column connections in seismic forces.

Course Outcome 6(CO6):

1. Analyse and design using ETABS a three storied RC building by static method and also determine modal mass and modal participation factor as per IS 1893 (PART 1): 2002 for the following data.

   Seismic zone = IV

   Floor height = 4.0m

   Length of building = 10m

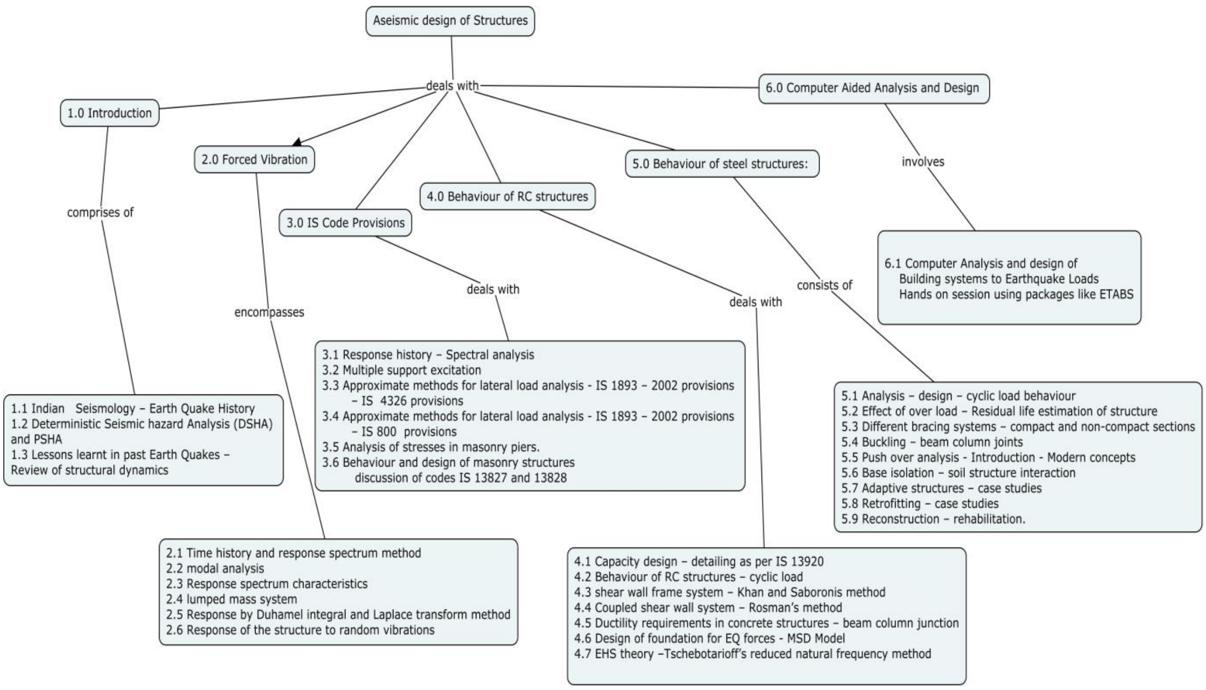
   Infill wall = 250mm thick in longitudinal and 150mm in transverse direction.

   Imposed load = 3.5 kN/m^2

   Size of columns = 250mm x 400mm.

   Size of beams = 300mm x 400mm in longitudinal and 300mm x 350mm in transverse direction: Depth of slab = 120mm.

Concept Map



Syllabus

Introduction: Indian Seismology – Earth Quake History –Deterministic Seismic hazard Analysis (DSHA) – PSHA -completeness Analysis – Seismic Hazard curves ,UHRS,GRA and– lessons learnt in past Earth Quakes –Review of structural dynamics - Forced Vibration**:** Response spectrum method - modal analysis – ground motion parameters – lumped mass system – shear building – symmetrical and unsymmetrical buildings – Response by Duhamel integral and Laplace transform method - Response of the structure to random vibrations and repeated loading – Tripartite response spectra problems -.Strong Ground Motion parameters –One dimensional Ground response analysis –Transfer function Response of layer over the half space - Estimation of frequency content parameters -Fourier Analysis to seismic signals -Selection of ground motion prediction relationships – Dynamic Soil properties –Field and Lab tests-– soil structure interaction –Liquefaction –mechanism –Problems on Liquefaction evaluation –Cyclic stress approach –Seed and Idriss method – Measures to overcome Liquefaction **Behaviour of RC structures**: **IS Code Provisions:**– lateral load analysis - IS codal provisions on Earthquake resistant design – Analysis of stresses in masonry piers - Behaviour and design of masonry structures -Capacity design – detailing as per IS 13920 - Behaviour of RC structures –Design of non structural member - lateral load analysis of un reinforced brick masonry building -cyclic load – shear wall frame system – Khan and Saboronis method – Coupled shear wall system – Rosman's method – ductility requirements in concrete structures -Design of foundation for EQ forces - MSD Model - EHS theory –Tschebotarioff's reduced natural frequency method **Behaviour of steel structures**: Lateral load analysis of steel structure - different bracing systems – design of bracing – cyclic load behaviour – Effect of over load – Residual life estimation of structure-Push over analysis -base isolation **Computer Aided Analysis and Design** (Only for Internal Assessment) Computer Analysis and design of Building systems to Earthquake Loads – Hands on session using packages like ETABS.

Reference Books

4. Anil.K.Chopra,“Dynamics of Structures” (Theory and Applications to Earthquake Engineering), Prentice Hall of India Private Limited, 2nd Edition, New Delhi, 2003.
5. Clough R W and Penzien J, “Dynamics of structures”, McGraw Hill
6. Jaykrishna, “Elements of earthquake engineering” , Saritha Prakasan, Naunchandi, Meerut.
7. Mukhopadhyay, M., "Structural Dynamics", Ane Books, India, 2006
8. Pankaj Agarwal and Manish Shrikandhe, “Earthquake Resistant Design of Structures”, PHI.
9. Park & Paulay, “Reinforced concrete”, McGraw-Hill.

List of national and international Standard Codes

1. IS:1893 - (Part I), Criteria for Earthquake Resistant structures-General Provisions and Buildings
2. IS:13935 – Repair and Seismic strengthening of buildings
3. IS:4326 - Earthquake Resistant Design and Constructions of buildings
4. IS:13827 – Improving Earthquake Resistance of Earthen buildings
5. IS: 13828 - Improving Earthquake Resistance of Low strength Masonry buildings.
6. IS: 13920 – Ductile detailing of RC Structures subject to Seismic forces.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.0	**Introduction**	
1.1	Indian Seismology – Earth Quake History	1
1.2	Deterministic Seismic hazard Analysis (DSHA)	
1.3	PSHA -completeness Analysis – Seismic Hazard curves	1
1.4	UHRS,GRA	
1.5	lessons learnt in past Earth Quakes	1
2.0	**Review of structural and soil dynamics**	
2.1	Response by Duhamel integral and Laplace transform method	2
2.2	Response of the structure to random vibrations and repeated loading	2
2.3	Tripartite response spectra problems	1
2.4	Strong Ground Motion parameters	1
2.5	One dimensional Ground response analysis	2
2.6	Transfer function Response of layer over the half space	1
2.7	Estimation of frequency content parameters	
2.8	Fourier Analysis to seismic signals	1
2.9	Selection of ground motion prediction relationships	

2.10	Dynamic Soil properties Field and Lab tests	2
2.11	soil structure interaction	1
2.12	Liquefaction Problems on Liquefaction evaluation	2
2.13	Cyclic stress approach –Seed and Idriss method – Measures to overcome Liquefaction	2
3.0	**Behaviour of RC structures**	
3.1	IS codal provisions on Earthquake resistant design	1
3.2	Seismic coefficient and Response spectrum method	2
3.3	Analysis of stresses in masonry piers	2
3.4	Capacity design problems	1
3.5	Design of non structural member	1
3.6	lateral load analysis of un reinforced brick masonry building	2
3.7	Design of shear wall – Khan and Saboronis method	1
3.8	Coupled shear wall system – Rosman's method	
3.9	Design of foundation for EQ forces -	1
3.10	MSD Model - EHS theory	1
3.11	Tschebotarioff's reduced natural frequency method	
4.0	**Behaviour of steel structures: Lateral load analysis of steel structure**	
4.1	different bracing systems	1
4.2	design of bracing ,cyclic load	
4.3	Effect of over load –	1
4.4	Residual life estimation of structure-	
4.5	Push over analysis	1
4.6	base isolation	1
5.0	**Computer Aided Analysis and Design Hands on session using packages like ETABS.**	1
	Total Hours	**36**

Course Designers:

Dr.R.Ponnudurai

14CERB0	EXPERIMENTAL TECHNIQUE AND INSTRUMENTATIONS	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course offers various experimental techniques and measurements needed for analyse and design of structures. The course covers the basic aspects of experimental stress analysis that includes exhaustive treatment of the most versatile techniques like photo elasticity and strain gauges.

Prerequisite

Engineering Physics, Structural Analysis 14CE420 strength of materials 14CE220

Course Outcomes

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

			Expected attainment level(%)	Expected proficiency level(grade)
CO1	Able to remember the various strain gauges and understand the principle of operation	Understand	70	A
CO2	Able to apply the principle to operation of the strain gauges into various practical problems	Apply		
CO3	Able to apply the photo elasticity theory to stress analysis.	Apply	70	A
CO4	Able to do understand various NDT technique and its principle of operation	Understand	70	A
CO5	Able to apply the principle model analysis to prototype structure.	Apply		
CO6	Able to do understand the various instrumentation involved in the measurement of structural parameters	Understand	70	A
			70	A
			70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO_1	PSO_2
CO31.	L	L	L	L	-	L	-	-	-	-	-	-	L	L
CO32.	S	M	M	M	-	L	-	-	-	-	-	-	L	L
CO3.	S	M	M	M	-	L	-	-	-	-	-	-	L	L
CO4.	L	L	L	L	-	L	-	-	-	-	-	-	L	L
CO5.	S	M	M	M	-	L	M	-	-	-	-	-	L	L

CO6.	L	L	L	L	-	L	-	-	-	-	-	-	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	10	10	10	10
Apply	30	30	30	30
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	50	50	50	50

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define cross sensitivity
2. List the types of strain gauges
3. Brief the principle of operation mechanical strain gauge
4. Explain the principle of Strain gauge Rosettes. Compare the available Rosettes and their applications.

Course Outcome 2 (CO2):

1. Four strain gauges,each of 100Ω resistance and gauge factor 2.0 ,are mounted on a steel cantilever and connected to Wheatstone bridge circuit as shown in fig. The bridge supply voltage is 6V.Find bridge output voltage,when a force of 100N is applied at the free end of the cantilever. $E=20X10^{10}$ $N/m^{2.}$
2. What do you understand by temperature compensation in connection with the electrical resistance strain gauge? Explain clearly the terms, selected melt gauges,dual element gauges and adjacent arm compensation

Course Outcome 3 (CO3):

1. Explain the elements of a plane polariscope.What are the difference between isoclinic and isochromatic fringes?
2. Explain the effect of a stressed model in a standard circular polaiscope using jones calculus
3. Derive the condition for extinction of light in crossed-crossed circular polariscope arrangement with monochromatic light source and stressed model, placed in the middle.

Course Outcome 4 (CO4):

1. Explain the principle of operation of Impact Echo method
2. Brief how Ground penetrating Radar helps to investigate the failures
3. Explain how cracks are determined by using Radiographic testing

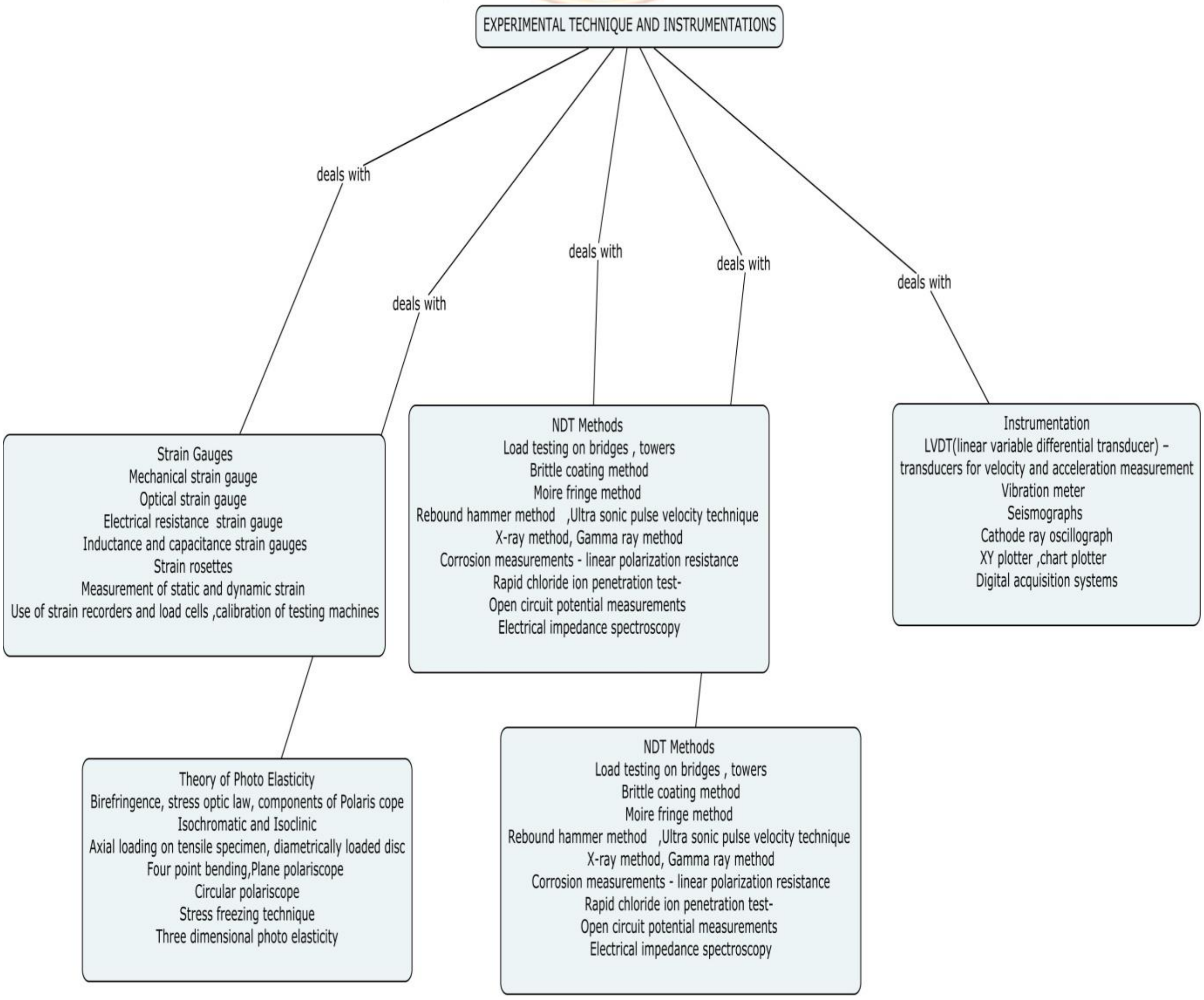
Course Outcome 5 (CO5):

1. Differentiate direct and indirect model analysis
2. Elaborate how moment deformater provides ILD for BM at internal sections of a model

Course Outcome 6(CO6):

1. Derive a general expression for the output voltage of Wheatstone Bridge circuit for different strain gauge combinations
2. Explain the principle of Strain gauge Transducers. With the help of neat sketch,
3. Explain the application of strain gauges in Load cells and Torque Transducers.

Concept Map



Syllabus

Strain Gauge - Mechanical strain gauge- Optical strain gauge- Electrical resistance strain gauge - Inductance and capacitance strain gauges - Strain rosettes- Measurement of static and dynamic strain- Use of strain recorders and load cells ,calibration of testing machines **Theory of Photo Elasticity -** Birefringence, stress optic law, components of Polaris cope - Isochromatic and Isoclinic - Axial loading on tensile specimen, diametrically loaded disc- Four point bending,Plane polariscope- Circular polariscope- Three dimensional photo elasticity **NDT Methods -** Load testing on bridges , towers- Brittle coating method- Moire fringe method - Rebound hammer method ,Ultra sonic pulse velocity technique- X-ray method, Gamma ray method- Corrosion measurements - linear polarization resistance- Rapid chloride ion penetration test- Open circuit potential measurements - Electrical impedance spectroscopy **Model Analysis** Structural similitude- Structural similitude - Structural and dimensional analysis - Buckingham pi theorem ,Muller Breslau's principle - Direct and indirect analysis , Begg Eny's deformeter .- Moment indicators **Instrumentation-** LVDT(linear variable differential transducer) –transducers for velocity and acceleration measurement- Vibration meter - Seismographs- Cathode ray oscillograph - XY plotter ,chart plotter - Digital acquisition systems

Reference Books

1. Dalley .J.W and Riley.W.F, "Experimental Stress Analysis", McGraw Hill Book Company, N.Y.1991.
2. K.K.Ramesh, Digital Photoelasticity – Advanced Techniques and Applications, Springer, 2000.
3. W.N.Sharpe (Ed), Springer Handbook of Experimental Solid Mechanics, Springer, 2008.
4. L.S. Srinath, M.R. Raghavan, K. Lingaiah, G. Gargesa, B. Pant, and K. Ramachandra, Experimental Stress Analysis, Tata Mc Graw Hill, 1984.
5. Ganesan.T.P, "Model Analysis of Structures", University Press, India, 2000.
6. Ravisankar.K and Chellappan.A., "Advanced Course on Non-Destructive Testing and Evaluation of Concrete Structures", SERC, Chennai, 2007.
7. Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi, 2006.
8. Sirohi.R.S., Radhakrishna.H.C, "Mechanical Measurements", New Age International (P) Ltd. 1997.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1	**Strain Gauges**	
1.1	Mechanical strain gauge	1
1.2	Optical strain gauge	1
1.3	Electrical resistance strain gauge	1
1.4	Inductance and capacitance strain gauges	1
1.5	Strain rosettes	1

1.6	Measurement of static and dynamic strain	1
1.7	Use of strain recorders and load cells ,calibration of testing machines	1
2	**Theory of Photo Elasticity**	
2.1	Birefringence, stress optic law, components of Polaris cope	1
2.2	Isochromatic and Isoclinic	1
2.3	Axial loading on tensile specimen, diametrically loaded disc	1
2.4	Four point bending, Plane Polariscope	1
2.5	Circular Polariscope	1
2.6	Stress freezing technique	1
2.7	Three dimensional photo elasticity	1
3	**NDT Methods**	
3.1	Load testing on bridges , towers	1
3.2	Brittle coating method	1
3.3	Moire fringe method	1
3.4	Rebound hammer method ,Ultra sonic pulse velocity technique	1
3.5	X-ray method, Gamma ray method	1
3.6	Corrosion measurements - linear polarization resistance	1
3.7	Rapid chloride ion penetration test-	1
3.8	Open circuit potential measurements	1
3.9	Electrical impedance spectroscopy	1
4	**Model Analysis**	1
4.1	Structural similitude	1
4.2	Structural and dimensional analysis	1
4.3	Buckingham pi theorem ,Muller Breslau’s principle	1
4.4	Direct and indirect analysis, Begg Eny’s deformeter .	1
4.5	Moment indicators	1
5	**Instrumentation**	1
5.1	LVDT(linear variable differential transducer) –transducers for velocity and acceleration measurement	1

5.2	Vibration meter	1
5.3	Seismographs	1
5.4	Cathode ray oscillograph	1
5.5	XY plotter ,chart plotter	1
5.6	Digital acquisition systems	1
	Total Hours	**36**

Course Designers:

1. Dr.R.Ponnudurai

14CERC0	**COMPUTER AIDED DESIGN**	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

The syllabus of subject "Computer Aided Design" of structures includes the main concepts of informatics, computer hardware and software, principles for design and types of operational systems (Windows), work with interpreter, compilers and linkage editors. The main aspects of programming with MS Visual C++ considered are: variables and types of data, arithmetical, logical and relational operations, main operators, functions, objects, classes, input-output operators, etc. This course provides the essentials of performing computer-aided design, from engineering rather than a purely mathematical point of view.

Prerequisite

Fundamentals of Mathematics, knowledge of Design of RCC 14CE610, prestressed concrete 14CEPF0 and steel structures 14CE670 and also algorithm and program development

Course Outcomes

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

Expected attainment level(%)	Expected proficiency level(grade)

CO1: Formulate algorithm for solving equations by matrix method and construct algorithm for computer aided design of truss problems	Apply	70	A
CO2: Construct algoritham for computer aided design of truss problem	Apply	70	A
CO3: Construct algorithm for computer aided design of reinforced concrete members	Apply	70	A
CO4: Construct algorithm for computer aided design of steel and light gauge steel members	Apply	70	A
CO5: Construct algorithm for analysis of prestressed concrete members	Apply	70	A
CO6: Develop computer aided analysis and design softwares		70	A

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO33.	S	S	S	-	S	-	M	S	S	S	-	-	M	M
CO34.	S	S	S	-	S	-	M	S	S	S	-	-	M	M
CO3.	S	S	S	-	S	-	M	S	S	S	-	-	M	M
CO4.	S	S	S	-	S	-	M	S	S	S	-	-	M	M
CO5.	S	S	S	-	S	-	M	S	S	S	-	-	M	M
CO6	S	S	S	-	S	-	M	S	S	S	-	-	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests	Terminal Examination

	1	2	3	
Remember	10	10	10	10
Understand	10	10	10	10
Apply	30	30	30	30
Analyse	-	-	-	-
Evaluate	50	50	50	50
Create	-	-	-	-

Course Level Assessment Questions

4. Write the equation for obtaining structure stiffness matrix.

CO1: Formulate algorithm for solving equations by matrix method and construct algorithm for computer aided design of truss problems List the methods of solving simultaneous equations.

5. Explain Gauss Elimination method of solving simultaneous equations.
6. Illustrate with an example the matrix stiffness method of solving a truss.
7. Determine the forces in the members of the truss shown in Fig.1 by matrix stiffness method. Take E = 200 GPa.

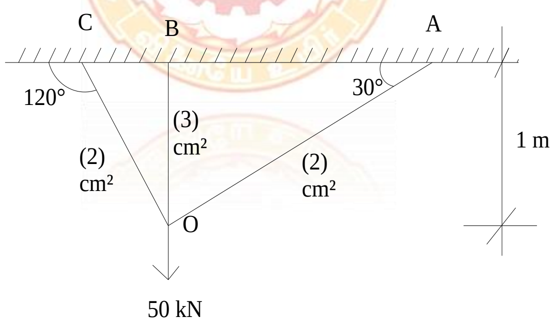


Fig.1

8. Solve the following system of equations by Gauss elimination method.

$$3x_1 - 4x_2 - x_4 = 2$$

$$x_2 + x_3 + 4x_4 = 3$$

$$x_1 - 3x_2 + 6x_3 - 2x_4 = -3$$

$$x_2 + 2x_3 + 3x_4 = -4$$

9. Generate the algorithm for solving simultaneous equations by Gauss Elimination Method.

CO2: Construct algorithm for computer aided design of reinforced concrete members

4. Write the algorithm for determination of bending moment coefficients for two way simply supported slab.
5. Compare the stress-strain relation for mild steel with that of cold formed steel.
6. Write the algorithm for determination of bending moment coefficients for two way simply supported slab
7. Compute the values of design chart for balanced and under reinforced rectangular sections.

8. Define stiffened elements in light gauge sections.

CO3: Construct algorithm for computer aided design of steel and light gauge steel members

9. Summarise the conditions for providing stiffeners in welded plate girder.
10. Determine the maximum uniformly distributed load inclusive of self weight that can be supported by the beam which has two light gauge channel sections without bent lips 200mm x 50mm are connected with webs to act as a beam. The thickness of channel is 4mm. The effective span of simply supported beam is 3.5m.
11. Determine the web and flange sections, intermediate and end bearing stiffeners required for a welded plate girder section which will be provided for a hall. The superimposed load exclusive of self weight is 150kN/m. The span of the girder is 20m.
12. Generate the detailed algorithm for finding load carrying capacity of a light gauge column section.
13. Write the algorithm for analysis and design of single and built up steel beam sections.
14. Write the algorithm for design of web and flange section of a welded plate girder.

4. Mention the various losses of prestress.

CO4**:** Construct algorithm for analysis of prestressed concrete members

5. Express the equations for analysis of prestressed concrete members due to self weight and prestress.
6. Compute the stresses at the central section for the following cases for a prestressed concrete beam.

    a.) Prestress + self weight (density of concrete = 24 kN/m^3)

    b.) Prestress + self weight + live load.

    The concrete beam is of symmetrical I-section spanning 8m has flange width and thickness of 200 and 60mm respectively. The overall depth of the beam is 400mm. The thickness of the web is 80mm. The beam is prestressed by a parabolic cable with an eccentricity of 15mm at the centre and zero at the supports with an effective force of 100kN. The live load on the beam is 2kN/m.

7. Outline the algorithm for analyzing prestressed concrete members.

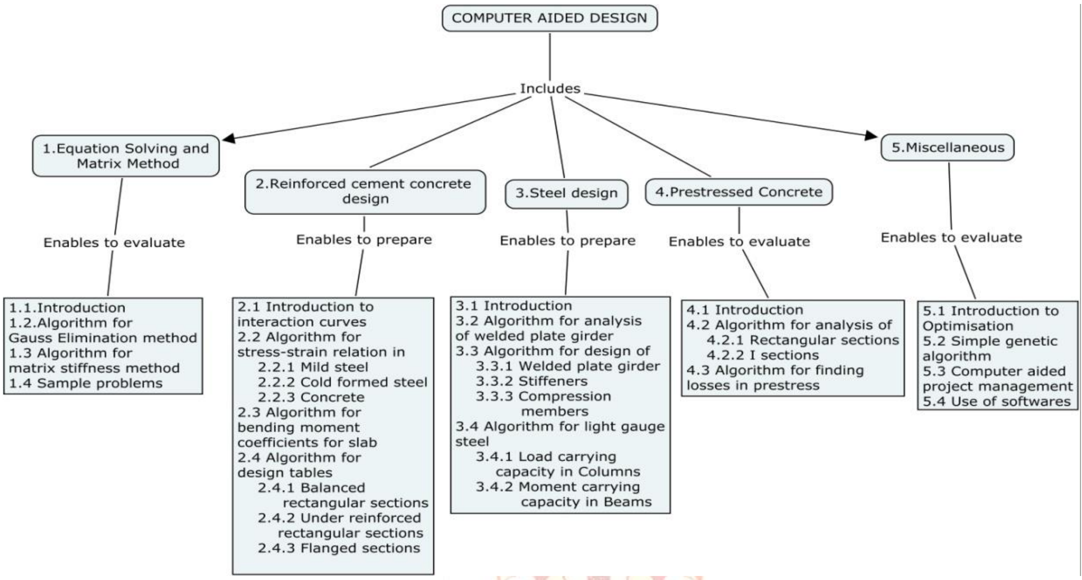
5. List the softwares for analysis and design of structural members.

CO5: Develop computer aided analysis and design softwares

6. Describe the different stages of computer aided design softwares.

7. Describe the step by step procedure of analysing and designing a two bay two storeyed portal frame using any computer aided design software.

Concept Map



Syllabus

Equation solving and Matrix method - algorithm for solving simultaneous equations – gauss elimination method – banded and semi-banded matrices – local and global coordinate system – element stiffness matrix – structure stiffness matrix – algorithm for solving trusses by matrix stiffness method. **Reinforced cement concrete design -** algorithm for stress-strain relationship in mild steel – cold formed steel – stress-strain relationship in concrete – algorithm for bending moment coefficients in slab – algorithm for developing design tables for beams – rectangular and flanged sections. **Steel design -** algorithm for analysis and design of compression members – algorithm for finding load carrying capacity of light gauge steel columns – algorithm for moment carrying capacity of light gauge steel beams. **Prestressed concrete -** algorithm for analysis of prestressed rectangular and i sections in flexure – algorithm for finding losses in prestress. **Miscellaneous -** introduction to optimisation – simple genetic algorithm – stages of computer aided analysis and design softwares – software applications.

Reference Books

1. Krishnamoorthy, C.S and Rajeev, S, "Computer Aided Design", Narosa Publication House, New Delhi, 2005.
2. Krishnaraju N, "Prestressed Concrete", Tata McGraw-Hill, New Delhi, 2006.
3. Pandit G, Gupta, S, "Structural Analysis – A Matrix Approach", McGraw-Hill Education, India, New Delhi, 2008.
4. Peter W, Christensen, A, "An Introduction to Structural Optimisation", Springer 2009.
5. Punmia B C and Jain,A.K, "Comprehensive Design of Steel Structures", Laxmi Publications, 2006.

Course Contents and Lecture Schedule

S.NO	TOPICS	NO. OF PERIODS
1	**Equation Solving and Matrix Method**	
1.1	Introduction	1

1.2	Various methods for solving simultaneous equations	1
1.3	Algorithm for solving simultaneous equations by Gauss Elimination method	2
1.4	Banded and semi-banded matrices	1
1.5	Element stiffness and structure stiffness matrices	1
1.6	Algorithm for solving truss problems by matrix stiffness method	2
2	**Reinforced cement concrete design**	
2.1	Introduction to interaction curves	1
2.2	Algorithm for developing stress-strain relation in mild steel	1
2.3	Algorithm for developing stress-strain relation in cold formed steel	1
2.4	Algorithm for developing stress-strain relation in concrete	1
2.5	Algorithm for developing bending moment coefficients for slab	1
2.6	Algorithm for developing design tables for balanced rectangular sections	1
2.7	Algorithm for developing design tables for under reinforced rectangular sections and flanged sections	1
3	**Steel Design**	
3.1	Introduction	1
3.2	Algorithm for design of compression members	2
3.3	Algorithm for finding load carrying capacity of light gauge steel columns	1
3.4	Algorithm for finding moment carrying capacity of light gauge steel beams	1
4	**Prestressed Concrete**	
4.1	Introduction	1
4.2	Algorithm for analysis of rectangular sections	2
4.3	Algorithm for analysis of I sections	2
4.4	Algorithm for finding losses in prestress	1
5	**Miscellaneous**	
5.1	Introduction to Optimisation	2
5.2	Simple genetic algorithm	2

5.3	Stages of Computer aided analysis and design softwares	2
5.4	Use of softwares – sample structural problems	2
5.5	Use of excel sheets	2
	Total Hours	**36**

Course Designers:

1. Dr. K.Sudalaimani ksciv@tce.edu
2. Dr.S.Nagan nagan_civil@tce.edu

14CERD0	**RESOURCES AND ENERGY RECOVERY FROM WASTE**	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

Solid waste is generated in tonnes a day throughout the world especially in urban centres. The disposal of solid waste is becoming much more complex due to toxic materials which pollute the environment and underground water. This course work is focused to deal with recovery of resources and energy from the waste for sustainable development particularly from solid waste which includes sludge sedimented from wastewater. The process of material recovery from solid waste to recycle is dealt in this course work. The process of energy recovery in the form of Thermal, Biofuels and green manure product from the solid waste is covered in detail. The course work also covers several case studies to recycle the usable materials recovered from solid waste with its socio-economic and legal considerations.

Prerequisite

- Solid Waste Management and Biological Treatment System

Course Objective

- Understand and apply the recovery process of the recyclable materials and energy recovery by various transformation processes from the solid waste.

Course Outcomes

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

			Expected attainment level(%)	Expected proficiency level (grade)
CO1.	Apply the various recovery processes and volume reduction processes on solid waste for sustainable development	Apply	70	A
CO2.	Develop biological process for transformation of solid waste to useful by-products	Apply	70	A
CO3.	Develop Bio-chemical process for transformation of solid waste to useful by-products.	Apply	70	A
CO4.	Develop Thermo-chemical process for transformation of solid waste to useful by-products.	Apply	70	A
CO5.	Analyze the recycling and recovery concepts of various solid wastes	Analyze	70	A
CO6.	Analyze the recycling and recovery concepts of various E- wastes	Analyze	70	A

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO_1	PSO_2
CO1	S	M	L	-	-	L	L	L	-	-	L	-		

CO2	S	M	M	-	-	-	-	L	-	-	L	-		
CO3	S	M	M	-	-	-	-	L	-	-	L	-		
CO4	S	M	M	-	-	-	-	L	-	-	L	-		
CO5	S	S	S	-	-	L	L	L	-	-	L	L		

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	50	50	30	30
Apply	30	30	50	50
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. **State Sustainable Development**
2. **State the objectives of processing of waste**
3. **Describe the material and energy flow management**
4. **Explain the various ways of recovery of resources from waste**
5. **Explain the process of segregation, sorting and its conveyance**
6. **Describe the process of size separation and density separation**
7. **Explain the process of equipment selection**

Course Outcome 2 (CO2):

1. Name various methods of composting
2. List the factors affecting composting
3. List the scope and importance of vermi culture
4. Name the species used for vermi culture
5. State vermi culture
6. Explain the mechanisms involved in Biological processing
7. Explain aerobic process of organic fraction
8. Design a suitable biological process of energy recovery of organic waste from vegetable markets
9. Describe the process of composting of organic waste

Course Outcome 3 (CO3):

1. **State the principles of anaerobic digester**
2. **Name some toxic substances which affects anaerobic disgestion**
3. **Explain the process of methane generation by anaerobic digestion**
4. **Explain the process of single stage and multi stage disgestors**
5. **Describe the commercially available anaerobic digestor technologies**
6. **Explain the process of collection of gas from anaerobic digestion**
7. Design a suitable biological process of methane energy recovery of organic waste from municipal solid waste

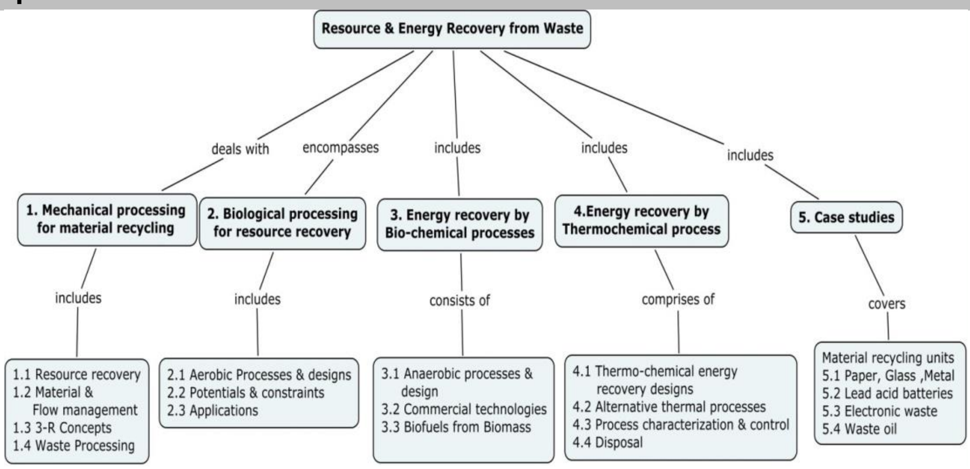
Course Outcome 4 (CO4):

1. State the principles of Thermal chemical conversion of waste to energy
2. Explain the process of energy recovery from incineration
3. Describe the process of incineration systems
4. Design a suitable Thermal chemical conversion process for energy recovery of municipal solid waste
5. Describe the procedure to determine stoichiometric air consumption
6. Explain the ways of calculating flue gas composition
7. Describe the process of pyrolysis and gasification
8. Explain the importance of cleaning of flue gases
9. Explain the treatment process of bottom ash
10. Explain utilization and disposal of bottom ash

Course Outcome 5 (CO5):

1. Explain the concept of life cycle approach
2. Explain the process of recycling technologies practiced for various materials
3. Explain the process of recycling technologies of E waste with a case study
4. Explain the process of recycling technologies of paper waste with a case study
5. Prepare a preliminary report for the resource recovery of Institutional waste from planning to the suitable transformation process. Assume the appropriate waste generated.

Concept Map



Syllabus

Mechanical processing for material recycling: Resource recovery for a sustainable development- Material and energy flow management and analysis - Systems and processes for reduction, reuse and recycling -Objectives of Waste processing-Source Segregation and

Hand Sorting-Waste Storage and Conveyance – Shredding – Pulping - Size Separation by Screens- Density Separation by Air Classification –magnetic and electromechanical separation processes- Design Criteria and Equipment selection**. Biological processing for resource recovery :** Mechanisms of Biological Processing – Aerobic Processing of Organic fraction - Composting methods and processes- factors affecting- Design of Windrow Composting Systems- In Vessel Composting- Compost Quality Control- Vermiculture: definition, scope and importance – common species for culture - Environmental requirements - culture methods- Applications of vermiculture- Potentials and constraints for composting in India-Largescale and decentralized plants. **Bio-chemical conversion of waste to energy :** Principles and Design of Anaerobic Digesters **–** Process characterization and control**-** The biochemistry and microbiology of anaerobic treatment - Toxic substances in anaerobic treatment -Methane generation by Anaerobic Digestion- Anaerobic reactor technologies – Commercial anaerobic Technologies- Single stage and multistage digesters-Digester design and performance-Gas collection systems-Methane Generation and Recovery in Landfills – Biofuels from Biomass**. Thermo-chemical conversion of waste to energy:** Principles and Design of Energy Recovery Facilities -Types and principles of energy conversion processes - Incinerator design - Mass Burn and RDF Systems- Composition and calorific value of fuels and waste, Determination of the stoichiometric air consumption, Calculation of the flue gas composition - grate firing designs, boiler design, removal of bottom ash, heat recovery- Emission Controls – flue gas cleaning, de-dusting, flue gas scrubbers, DeNOx processes, dioxins and furans - Alternative thermal processes: co-incineration, pyrolysis, gasification, plasma arc – Process characterization and control-waste heat recovery- Bottom ash: Quantity, quality, treatment, utilization, disposal- Facility design- decentralized mobile plants- Planning and construction of incineration plants**. Case studies:** Recycling technologies for paper, glass, metal, plastic – Used Lead Acid Battery Recycling –End of Life Vehicle Recycling – Electronic Waste Recycling – Waste Oil Recycling.

Reference Books

1. Aarne Veslind and Alan E Rimer (1981), “Unit operations in Resource Recovery Engineering“, Prentice Hall Inc., London.
2. Charles R Rhyner (1995),Waste Management and Resource Recovery, Lewis Publishers
3. Chiumenti, Chiumenti, Diaz, Savage, Eggerth, and Goldstein *, Modern Composting Technologies* , JG Press October 2005.
4. Gary C. Young (2010) Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, John Wiley & Sons
5. Manser A G R, Keeling A A (1996). Practical handbook of processing and recycling on municipal waste. Pub CRC Lewis London, ISBN 1-56670-164.

Course Contents and Lecture Schedule

Module No	Topic	No. of Lectures
1.0	**Mechanical processing for material recycling**	
1.1	Resource recovery for a sustainable development	1
1.2	Material and energy flow management and analysis	1
1.3	Systems and processes for reduction, reuse and recycling	1
1.4	Objectives of Waste Processing-Source Segregation and Hand Sorting	1
1.4.1	Waste Storage and Conveyance – Shredding – Pulping	1

1.4.2	Size Separation by Screens- Density Separation by Air Classification –magnetic and electromechanical separation processes	1
1.4.3	Design Criteria and Equipment selection	2
2.0	**Biological processing for resource recovery**	
2.1	Mechanisms of Biological Processing – Aerobic Processing of Organic fraction	1
2.1.1	Composting Methods and processes- factors affecting	1
2.1.2	Design of Windrow Composting Systems- In Vessel Composting- Compost Quality Control	1
2.2	Potentials and constraints for composting in India-Largescale and decentralized plants.	1
2.3	Vermiculture: definition, scope and importance – common species for culture	1
2.3.1	Environmental requirements - culture methods- Applications of vermiculture	1
3.0	**Bio-chemical conversion of waste to energy**	
3.1	Principles and Design of Anaerobic Digesters – Process characterization and control	1
3.1.1	The biochemistry and microbiology of anaerobic treatment - Toxic substances in anaerobic treatment	1
3.1.2	Methane generation by Anaerobic Digestion	1
3.2	Anaerobic reactor technologies – Commercial anaerobic Technologies	1
3.2.1	Single stage and multistage digesters- Digester design and performance	1
3.3	Gas collection systems-Methane Generation and Recovery in Landfills – Biofuels from Biomass	1
4.0	**Thermo-chemical conversion of waste to energy**	
4.1	Principles and Design of Energy Recovery Facilities	1
4.1.1	Types and principles of energy conversion Processes	1
4.1.2	Incinerator design - Mass Burn and RDF Systems- Composition and calorific value of fuels and waste,	1
4.1.3	Determination of the stoichiometric air consumption, Calculation of the flue gas composition	1
4.1.4	Grate firing designs, boiler design, removal of bottom ash, heat recovery	1
4.1.5	Emission Controls – flue gas cleaning, de-dusting, flue gas scrubbers, DeNOx processes, dioxins and furans	1
4.2	Alternative thermal processes: co-incineration, pyrolysis, gasification, plasma arc	1
4.3	Process characterization and control- waste heat recovery- Bottom ash: Quantity, quality,	2
4.4	Bottom ash treatment, utilization, disposal- Facility design- decentralized mobile plants	2
4.4.1	Planning and construction of incineration plants	1
5.0	**Case studies - Material recycling units**	
5.1	Recycling technologies for paper, glass, metal, plastic	1
5.2	Used Lead Acid Battery Recycling –End of Life Vehicle Recycling	1

5.3	Electronic Waste Recycling	1
5.4	Waste Oil Recycling – Solvent Recovery	1
	TOTAL	**36**

Course Designers

1. Mr. V. Ravishankar environmentengr@tce.edu
2. Mr. R.K.C. Jeykumar rkcjciv@tce.edu

14CERE0	INDUSTRIAL WASTEWATER MANAGEMENT	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

As a fastly growing country, India is flooded with very good numbers of small, medium and large sized industries. The liquid effluent generated from such industries would pose a great danger to the environment, if they are not managed properly. Hence, industrial wastewater management will be of great importance in maintaining the quality of the environment for sustainable living. This course work deals with characterization of industrial effluents, its impact on the environment, possible preventive measures against generation of wastes and treatment and reuse option for the generated wastewater.

Prerequisite

Knowledge on characterization of wastewater (14CE440), physico-chemical treatment and biological treatment.

Course Outcomes

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

			Expected attainment level(%)	Expected proviciency level(grade)
CO1.	Fix the characteristics of the wastewater generated from any industry and identify factors influencing their generation	Apply	70	A
CO2.	Identify the means and methods to reduce the quantity of generation of wastewater by performing source reduction techniques and waste audit.	Apply	70	A
CO3.	Develop appropriate treatment systems for the wastewater generated from the industries.	Apply	70	A
CO4.	Identifythe possible recycling and reuse opportunities for the generated wastewater and residuals by employing suitable treatment units.	Apply	70	A
CO5.	Investigate the feasibility and benefits of individual, common and joint treatment of industrial wastewater.	Apply	70	A
CO6.	Suggest suitable treatment schemes for wastewater generated from specific industries based on their characteristics	Apply	70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO_1	PSO_2
CO1	S	M	L	L	-	M	S	-	-	-	-	-	M	L
CO2	S	S	S	S	-	S	S	M	M	M	-	-	M	M
CO3	S	S	S	M	-	M	S	-	-	-	-	-	M	L
CO4	S	S	S	S	-	S	S	S	S	S	-	-	M	M
CO5	M	S	S	S	-	S	S	-	M	S	-	-	M	M

CO6	S	S	S	S	-	S	S	M		-	-	M	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	50	30	30	30
Apply	30	50	50	50
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the importance of population equivalent of an industrial effluent.
2. Describe the typical impacts of industrial wastewater on water bodies.
3. Discuss the classification of wastewater generated from an industry.

Course Outcome 2 (CO2):

1. Illustrate the good operating practices that would lead to pollution prevention.
2. Demonstrate the process of segregation and recovery of waste in waste volume reduction.
3. Perform a waste audit programme in an industry and highlight the various stages involved in it.

Course Outcome 3 (CO3):

1. Compute the volume of equalization basin required for the following flow regime.

Time (hrs)	02.00	04.00	06.00	08.00	10.00	12.00	14.00	16.00	18.00	20.00	22.00	24.00
Flow rate (m^3/d)	8000	6000	9400	12,800	13,000	14,400	12,000	9600	11,000	8000	9000	8400

2. A wastewater is to be treated with activated carbon to remove residual COD. The following data were obtained from a laboratory adsorption study in which 1 g of activated carbon was added to a beaker containing 1 L of wastewater at selected COD values. Using these data, determine the more suitable isotherm.

Initial COD (mg/L)	140	250	300	340	370	400	450
Equillibrium COD (mg/L)	5	12	17	23	29	36	50

3. A wastewater to be desalinized by reverse osmosis using a thin-film composite membrane. Determine the required membrane area, the rejection rate, and the concentration of the concentrate system.

Flowrate	m^3/d	10,000
Influent TDS	g/m^3	2700
Effluent TDS	g/m^3	225

Flux rate coefficient k_w	/sec	1.5x 10^{-6}
Mass transfer rate coefficient, k_i	m/s	1.8x 10^{-6}
Net operating pressure	Kpa	3000
Recovery	%	86

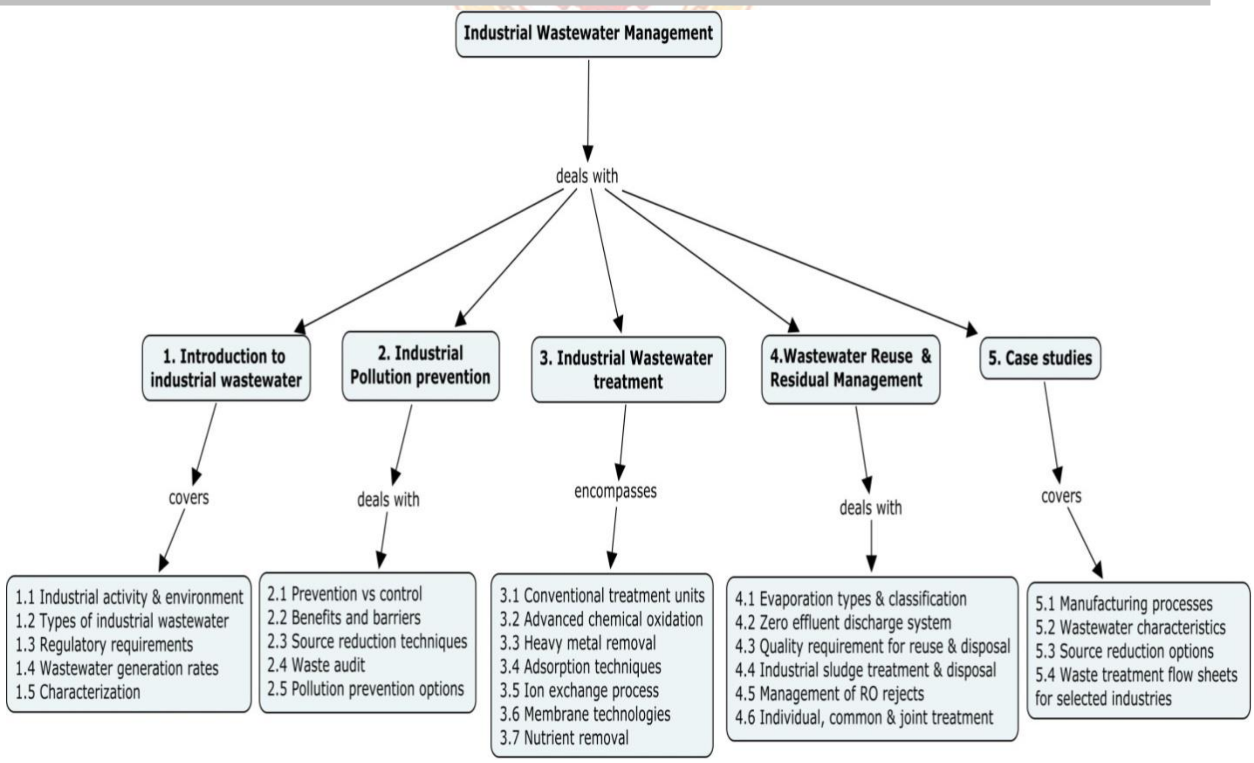
Course Outcome 4 (CO4):

1. The sludge production having 96% moisture content from a wastewater treatment plant is 1000 kg on dry solid basis. The solid contain 70% volatile matter with a specific gravity of 1.02 and 30% mineral matter with a specific gravity of 2.5. Determine the volume of raw and digested sludge if reduction in volatile solids is 55% during digestion and moisture content of digested sludge is 92%.
2. Explain the quality requirements for wastewater reuse, suggest a treatment scheme to achieve the above for an Industrial effluent.
3. Explain the role of evaporates in achieving effluent quality requirements.

Course Outcome 5 (CO5):

1. Exhibit the positives and issues in the joint treatment of industrial waste with municipal waste.
2. Identify and explain favourable factors in the common effluent treatment facility.
3. Compare individual treatment with joint treatment and identify the challenges.

Concept Map



Syllabus

Introduction to industrial wastewater: Industrial scenario in India – industrial activity and environment, uses of water by industry, sources and types of industrial wastewater. Regulatory requirements for treatment of industrial waste water, industrial waste survey, industrial waste water generation rates, characterization and variables, population equivalent. **Industrial Pollution Prevention:** Prevention Vs Control of industrial pollution – benefits and barriers. Source reduction techniques – waste audit, evaluation of pollution prevention options, environmental statement as a tool for pollution prevention, waste minimization circles. **Industrial Wastewater Treatment:** Equalization – neutralization, oil separation, flotation, precipitation, Aerobic and anaerobic biological treatment – sequencing batch reactors, high rate reactors(Recall) Advanced Chemical oxidation – Electro chemical oxidation, wet air oxidation, ozonation, photocatalysis, Other Treatment Processes Heavy metal removal, Refractory organics separation by adsorption. ion exchange, membrane technologies, nutrient removal. **Wastewater Reuse and Residual management:** Evaporation- Evaporators types and classification. Zero effluent discharge systems - Quality requirements for wastewater reuse, industrial reuse, disposal on water and land. Residuals from industrial wastewater treatment units - quantification and characteristics of sludge - thickening, digestion, conditioning, dewatering and disposal of sludge. Management of RO rejects. Individual and common effluent treatment plants – combined treatment of industrial waste water and domestic/municipal wastewater**.** **Case Studies:** Industrial manufacturing process description, waste water characteristics, source reduction options and waste treatment flow sheet for textiles, tanneries, pulp and paper, metal finishing, sugar and distilleries.

Reference Books

1. Arceivala, S.J., “Wastewater Treatment for Pollution Control”, Tata McGraw Hill, 1998.
2. Eckenfelder, W.W., “Industrial Water Pollution Control”, McGraw – Hill, 2000.
3. Frank Woodard, Industrial Waste Treatment Handbook, Butterworth Heinemann, New Delhi, 2001.
4. Paul L. Bishop “Pollution Prevention: - Fundamentals and Practice”, McGraw – Hill International, 2000.
5. World Bank Group, “Pollution Prevention and Abatement Handbook – Towards Cleaner Production”, World Bank and UNEP, Washington.D.C, 1998.

Course Contents and Lecture Schedule

Module No	Topics	No. of Lectures
1.0	**Introduction to industrial wastewater**	
1.1	Industrial scenario in India – industrial activity and environment - Uses of water by industry	1
1.2	Sources and types of industrial wastewater	1
1.3	Regulatory requirements for treatment of industrial wastewater	1
1.4	Wastewater generation rates	1
1.5	Characterization and variables, population equivalent	2
2.0	**Industrial Pollution Prevention**	
2.1	Prevention Vs Control of industrial pollution	1
2.2	Benefits and barriers	1
2.3	Source reduction techniques	1
2.4	Waste audit	1
2.5	Evaluation of pollution prevention option	1
2.5.1	Environmental statement	1
2.5.2	Waste minimization circles – PCB Norms for water usage in industries	1
3.0	**Industrial Wastewater Treatment**	
3.1	Recall of Conventional treatment system	1
3.2	Advanced chemical oxidation- Electro-chemical oxidation	1

3.2.1	Wet air oxidation - Ozonation - Photocatalysis	1
3.3	Heavy metal removal	1
3.4	Refractory organics separation by adsorption	1
3.5	Ion exchange	1
3.6	Membrane technologies	2
3.7	Nutrient removal	1
4.0	**Wastewater Reuse and Residual Management**	
4.1	Evaporation- Types of evaporators and classification	1
4.2	Zero effluent discharge systems	1
4.3	Quality requirement for reuse and disposal	1
4.4	Quantification and characteristics of sludge	1
4.4.1	Thickening, digestion, conditioning, dewatering and disposal of sludge.	2
4.5	Management of RO reject	1
4.6	Individual, common and joint treatment	2
5.0	**Case Studies**	
5.1	Industrial manufacturing processes, wastewater characteristics, Source reduction options and waste treatment flow sheet for textiles, tanneries, pulp and paper, metal finishing, sugar and	5
	TOTAL	**36**

Course Designers

1. Dr. T. Vel Rajan tvciv@tce.edu
2. Mr. R. K. C. Jeyakumar rkcjciv@tce.edu

14CERF0	SUSTAINABLE MANAGEMENT OF URBAN ECOLOGY	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course provides an overview of, and engagement with, various theoretical perspectives, debates and research practices in urban ecology, urban ecosystems, and urban sustainability. At the intersection of increasing urbanization and ecological crises, there has been an intense theoretical debate on how to understand and research urban nature and urban ecology in a sustainable manner. This course work covers the concept of sustainable management especially in the urban environment. It also explains the various environmental issues in an urban scenario and its impacts on ecology. It provides exposure to various issues in the management of urban water resources and wastewater. The future of Urban ecosystems and managing the climate change through the concept of future proofing is also addressed in the course work.

Prerequisite

Basic knowledge on Ecology, Environment Science (14CE250) and wastewater engineering (14CE440)

Course Outcomes

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

			Expected Attainment Level in %	Expected Proficiency Level in grade
CO1	Explain the concept of sustainable development in the urban perspective	Understand		
CO2	Describe the concept of urban ecology and its framework	Understand		
CO3	Apply the Urban water management tools and models	Apply		
CO4	Illustrate the present scenario and introduce eco friendly techniques to manage the wastewater	Understand		
CO5	Develop the future urban ecosystems keeping the climate change as a constraint	Apply		

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO_1	PSO_2
CO1	L	L	-	-	-	L	M	-	-	-	-	-		
CO2	L	L	-	-	-	L	M	-	-	-	-	-		
CO3	S	M	L	-	L	L	M	-	-	-	-	-		
CO4	L	L	-	-	-	L	M	L	-	-	-	L		

CO5	S	M	M	-	L	L	M	L	-	-	-	L		

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	80	50	50	50
Apply	-	30	30	30
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Describe the Principles of Sustainable Development.
2. List the Millennium Development Goals.
3. Discuss the economic dimensions of Urban sustainability.
4. Explain the Ecological Foot Print.

Course Outcome 2 (CO2):

1. Discuss the various theories of Urban Ecology.
2. Describe concept of Ecocity
3. Distinguish: Smart City and Compact city
4. Demonstrate the Urban Ecological Framework with a case study.

Course Outcome 3 (CO3):

1. Draw the Urban Water Cycle.
2. Define: IWRM
3. List the applications of IWRM
4. Apply the concept of IWRM to your city and comment on the outcome.
5. Solve the Interstate water disputes using IWRM concept.

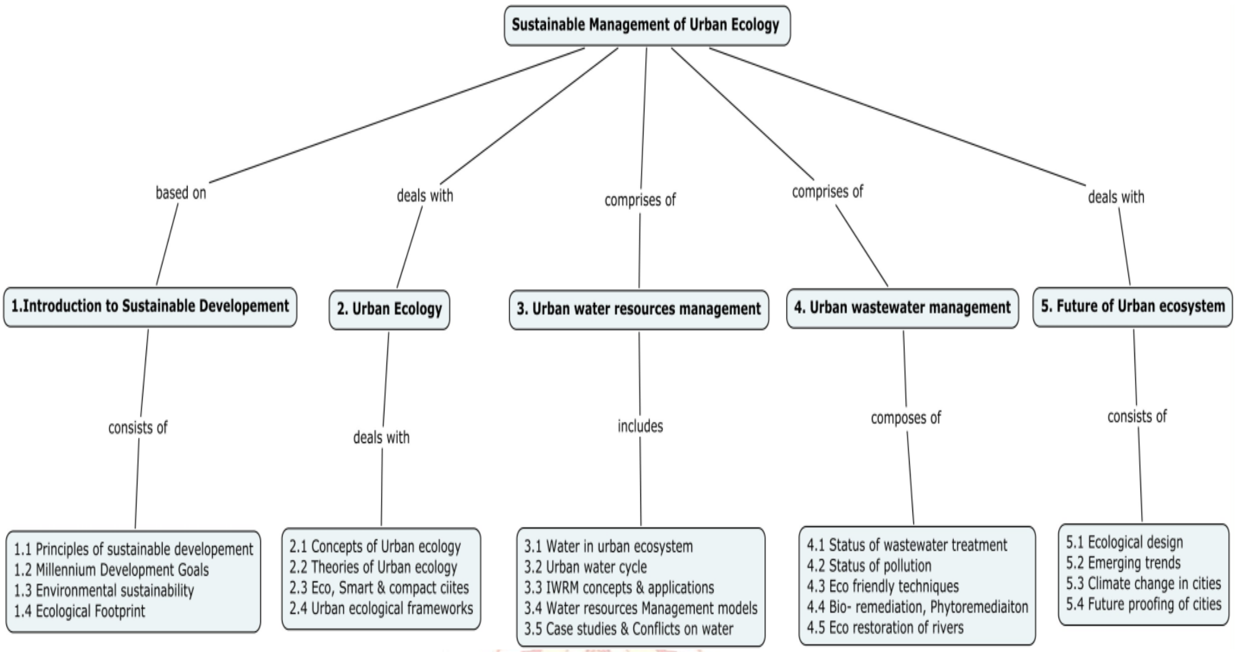
Course Outcome 4 (CO4):

1. Sequence the status of wastewater generation, collection, treatment and disposal in the country.
2. Describe the impacts of improper disposal sewage on eco system
3. Differentiate: Bio Remediation and Phytoremediation.
4. Illustrate a Eco restoration of river project in India.

Course Outcome 5 (CO5):

1. Discuss the emerging trends and Technologies in Urban ecology.
2. Produce the results of Future Proofing Cities done for Madurai city and comment on it.
3. How to adapt the climate change impacts in Cities?
4. Write components of Ecological Design.

Concept Map



Syllabus

Introduction to Sustainable Development: Definitions and principles of Sustainable Development –Environment and Development linkages –Millennium Development Goals **Environmental Sustainability:** Planning, Measuring Sustainability - Carrying Capacity and its limits - Social Capital and its limits- Urban sustainability, Social, Economic , Ecological dimensions, Concept of Ecological Foot print **Urban Ecosystem** Concepts and theories of urban ecology**-** Linkages with sustainable urbanism – Concepts of Eco cities, smart cities, compact cities- Urban Ecosystem Challenges and opportunities – Urban areas and ecological services, Urban Ecological Frameworks **Urban water resources management:** Water in urban ecosystem – Urban Water Cycle - storm water management practices – Water harvesting Structures – IWRM concepts and applications to Urban Water management - Integrated urban water planning– Water Resources management models and Water policy of Developed nations- National water Policy -Conflicts on water between Interstate and country – water Pricing – Case studies **Urban wastewater management:** Status of Wastewater treatment and disposal, pollution in India – Impacts on ecosystem, Eco friendly treatment systems- concept of decentralization – Bio remediation, Phytoremediation-Wastewater management policy and models of Developed nations– eco restoration of rivers – Case studies. **Futures of Urban Ecosystems** Scenario Planning and Adaptive Management, Ecological Design, Emerging Trends and Technologies, Integrated Models, Climate modifications and managing climate change challenges in cities, Adaptation and mitigation measures to make cities resilient Future proofing of cities.

Reference Books

1. Neil S. Grigg., “Urban Water Infrastructure Planning – Management and Operations”, John Wiley and Sons, 1986.
2. Philip James, Jari Niemelajurgen H . Breuste “Urban Ecology: Patterns, Processes and Applications”, OUP Oxford, 2011.
3. Tracer Strange and Anne BAley ,“Sustainable Development –Linking economy,Society , environment” , StatLink from OECD Publishing 2008.

4. UNU/IAS Report ,"Defining an Ecosystem Approach to Urban Management and Policy Development" March 2003 .
5. Zhifeng Yang "Eco- Cities: A Planning Guide (Applied Ecology and Environmental Management)" CRC Press, 2012.

Course Contents and Lecture Schedule

Module No	Topics	No of Lectures
1.0	**Introduction to Sustainable Development**	
1.1	Definitions and principles of Sustainable Development - History and emergence of the concept of Sustainable Development	1
1.2	Environment and Development linkages - Globalization and environment- Millennium Development Goals: Status (global and Indian)	1
1.3	Environmental Sustainability Planning Measuring Sustainability - Carrying Capacity And its Limits	1
1.4	Social Capital And its Limits	1
1.5	Introduction to urban sustainability	1
1.6	Social dimensions, Economic dimensions, Ecological dimensions	1
1.7	Physical aspects	1
1.8	Concept of Ecological Foot print.	1
2.0	**Urban ecology**	
2.1	Concepts and theories of urban ecology and linkages with sustainable urbanism	1
2.2	Concepts of Eco cities, smart cities, compact cities etc.	1
2.3	Urban Ecosystem Challenges and opportunities of urban, rural and periurban growth,	1
2.4	Processes in human population growth, urbanization and implications for urban ecology	1
2.5	Urban areas and ecological ecosystem services	1
2.6	Urban Ecological Frameworks, the principles and frameworks of ecology	1
2.7	Environmental perspectives on Urban master plans	1
2.8	Institutions working on Water, Environment- National / International levels	1
3.0	**Urban water resources management**	
3.1	Water in urban ecosystem	1
3.2	Urban Water Cycle	1
3.3	Urban water resources planning and organization aspects	1
3.4	Rainfall- runoff- Groundwater Recharge in urban regions	1
3.5	Storm water management practices storage capacity of urban components	1
3.6	Water harvesting Structures	1
3.7	IWRM – concepts and applications to Urban Water management and Distribution	1
3.8	Integrated urban water planning	1
3.9	Water Resources management models and Water policy of Developed nations	1
3.10	Case studies -Conflicts on water- Interstate/ country – water	1

	Pricing	
4.0	**Urban wastewater management**	
4.1	Status of Wastewater treatment and disposal on India/ developed nations	1
4.2	Status of pollution	1
4.3	Eco friendly treatment systems-concept of decentralization	1
4.4	Bio remediation, Phytoremediation	1
4.5	Wastewater management policy and models of Developed nations-Case studies	1
4.6	Case study on restoration of rivers	1
5.0	**Futures of Urban Ecosystems**	
5.1	Scenario Planning and Adaptive Management	1
5.2	Ecological Design, Emerging Trends and Technologies	1
5.3	Integrated Models, Climate modifications and managing climate change challenges in cities,	1
5.4	Adaptation and mitigation measures to make cities resilient Future proofing of cities	1
	TOTAL	**36**

Course Designer

Dr. S. Chandran schandran@tce.edu

tcomes

14CERGO	ORGANIZATIONAL BEHAVIOUR	Category	L	T	P	Credit
		PE	4	0	0	4

To impart knowledge on the importance of Organization Behaviour (OB), individual and group dynamics and organizational processes.

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

		Expected attainment level(%)	Expected proficiency level(grade)
(CO1) Understand the meaning, importance, scope and different approaches of OB	**Understand**	70	A
(CO2) Explain the categories, dimensions and physiology of emotional intelligence and applications of emotions to OB	**Apply**	70	A
(CO3) Explain the determinants, theories and attributes of personality, apply process and theories for motivation and leadership	**Apply**	70	A
(CO4) Explain the need, importance of Group dynamics in OB and strategies of organizational culture.	**Apply**	70	A
(CO5) Explain and apply strategies for organisational culture	**Apply**	70	A
(CO6) Understand the need, influencing factors for organizational change and strategies for reducing change	**Understand**	70	A

vel Assessment Questions

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO35.	---	---	---	---	---	L	L	---	---	---	---	---	L	L
CO36.	L	L	---	M	---	M	M	M	M	S	M	---	L	M
CO3	L	M	L	---	---	M	M	M	M	S	M	---	M	M
CO4	---	M	M	---	---	S	M	M	S	S	M	---	L	M
CO5.	---	L	M	L	---	M	M	M	L	---	M	---	---	M
CO6	---	L	M	L	---	M	M	M	L	---	M	---	---	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	50	40	40	40
Apply	30	40	40	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Outcome 1(CO1):

92. "Organizational theories should follow the contingency approach". Discuss and Comment on the accuracy of this statement.
93. Define Organizational Behaviour. Mention its need for study in an industry
94. Discuss how globalization influences organizational behavior

Course Outcome 2 (CO2):

1. After few months on a job, Mr.X has experienced several emotional episodes ranging from frustration to joy about work he has been assigned. Use the attitude model to explain how these emotions affects Mr.X's level of job satisfaction with the work itself
2. "Happy employees create happy customers", Discuss.
3. Describe the dimensions of emotional intelligence

Course Outcome 3 (CO3):

1. Find two newspaper ads for management or executive positions. What leadership competencies are mentioned in these ads? If you were on the selection panel, what methods would you use to indentify these competencies in job applicants?
2. Explain why values have gained importance in organizations
3. List the elements of Lewin's force field analysis model
4. Explain how personality relates to Holland's model of vocational choice

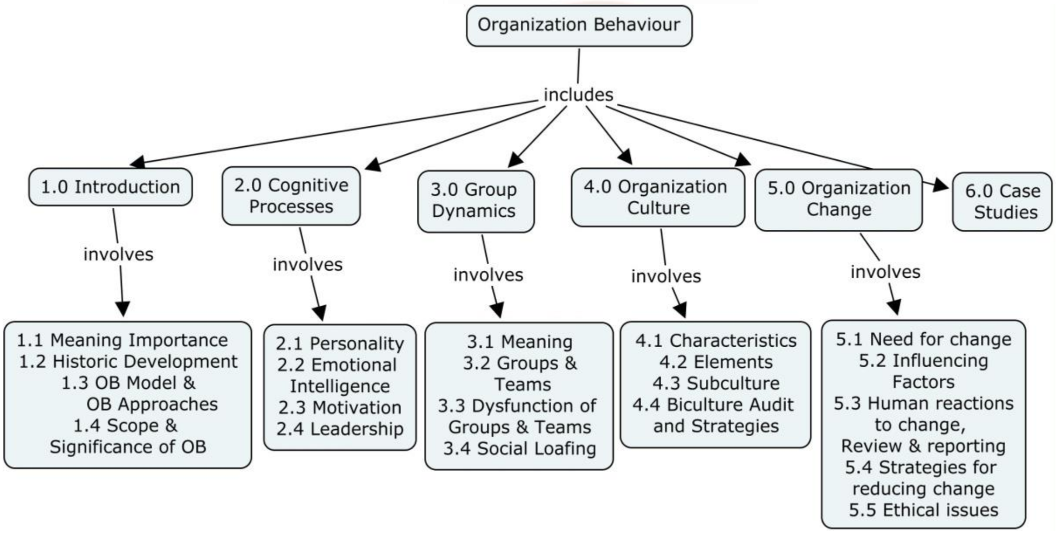
ap

Course Outcome 4 (CO4):

1. "Organizations are more likely to succeed when they have an adaptive culture". Give your comments on the statement with reasons
2. Identify the five types of individual behavior in organizations
3. A steel industry redesigned its production facilities around a team-based system. However the president of the industry believes that employees will not be motivated unless they receive incentives based on their individual performance. Give explanations why the industry should introduce team-based rather than individual rewards in this setting.
4. Differentiate between team and group with examples

Course Outcome 5(CO5):

1. Identify changes in work place in recent years
2. List the five anchors on which organizational behavior is based
3. Compare and contrast Maslow's needs hierarchy theory with Alderfer's ERG theor



Introduction to OB- Definition, Meaning and Importance of OB, Historic developments of OB, Hawthorne experiment, Basic OB Model, Different approaches to OB, Contributing disciplines to OB, Scope of OB, Significance of OB. **Personality-** Definition, Origin of the word Personality, Determinants of Personality, Theories of Personality (Psychoanalytic theory, Self theory, Holland's personality theory, Myers Briggs Type Indicators and Big 5 personality theory), Attributes of personality. **Emotional Intelligence-** Definition and Meaning, Categories of intelligence, EI

Dimensions, Physiology of EI, OB applications of emotions. **Motivation-** Definition, Meaning, Characteristics of Motivation, Process of Motivation, Theories of Motivation (Maslow's need theory, ERG theory, Hertzberg theory, Expectancy theory, Theory X & Y, McClelland's theory of needs, Goal setting theory, Equity theory), Incentives for Motivation. **Leadership -** Definition and Meaning, Styles of leadership, Theories of leadership (Trait theory, Ohio state theory, Managerial grid, Contingency theory, Path goal theory, Leader Member Exchange(LMX), Transactional & transformational leadership theory, Charismatic and Visionary leadership theory), Conflict and resolution. **Group Dynamics -** Definition and Meaning, Difference between Group and Team, Groups in Organization, Team Effectiveness model, Troubles with team, Social loafing- law of requisite variety- Ashby theory. **Organizational Culture-** Meaning and Definition, Characteristics of Organizational culture, Elements of Organizational culture, Organizational sub culture, Artifacts for Organizational culture, Bicultural audit, Strategies to merger different organizational culture. **Organizational Change -** Meaning, need for change, Factors of Organizational change, Lewin's forced field model, Human reactions to change, Organization - Control, review and updating. Resistance to change, Strategies for reducing change, Ethical issues in Organizational change. **Case Studies**.

References

1. Fred Luthans, "Organisational Behaviour", McGraw-Hill International Edition., Tenth Edition, 2005.
2. Kreitner Robert., Kinicki Angelo.,"Organisational Behaviour", Illinois, Irwin Inc., 1997.
3. Robbins P.Stephen., "Organizational Behavior", New Delhi, Prentice-Hall of India., Eigth Edition, 1999.
4. Steven L. McShane, Mary Ann Von Glinow, "Organisational Behaviour", New Delhi, Tata McGraw-Hill Edition. third reprint, 2005.
5. Vlad Dimitrov, "Law of Requisite Vorticity in Human Dynamics", http://www.zulenet.com/vladimirdimitrov/pages/vorticity.html

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	**Introduction to Organization Behaviour**	
1.1	Definition, Meaning and Importance of OB	1
1.2	Historic developments of OB, Hawthorne experiment	1
1.3	Basic OB Model, Different approaches to OB	2
1.4	Contributing disciplines to OB, Scope of OB, Significance of OB	1
2.0	**Cognitive Processes of Organization Behaviour**	
2.1	**Personality**	
2.1.1	Definition, Origin of the word Personality, Determinants of Personality	1
2.1.2	Theories of Personality - Psychoanalytic theory, Self theory	1

2.1.3	Theories of Personality - Holland's personality theory & Myers Briggs Type Indicators)	1
2.1.4	Theories of Personality - Big 5 personality theory	1
2.1.5	Attributes of personality	1
2.2	**Emotional Intelligence**	
2.2.1	Definition and Meaning, Categories of intelligence	1
2.2.2	EI Dimensions, Physiology of EI	1
2.2.3	OB applications of emotions	1
2.3	**Motivation**	
2.3.1	Definition, Meaning, Characteristics of Motivation	1
2.3.2	Process of Motivation	1
2.3.3	Theories of Motivation - Maslow's need theory, ERG theory	1
2.3.4	Theories of Motivation - Hertzberg theory, Expectancy theory	2
2.3.5	Theories of Motivation - Theory X & Y, McClelland's theory of needs	2
2.3.6	Theories of Motivation - Goal setting theory, Equity theory	2
2.3.7	Incentives for Motivation	2
2.4	**Leadership**	
2.4.1	Definition and Meaning, Styles of leadership	1
2.4.2	Theories of leadership -Trait theory, Ohio state theory	1
2.4.3	Theories of leadership - Managerial grid, Contingency theory	1
2.4.4	Theories of leadership - Path goal theory, Leader Member Exchange(LMX)	2
2.4.5	Theories of leadership - Transactional & transformational leadership theory	1
2.4.6	Theories of leadership - Charismatic and Visionary leadership theory. Conflicts and resolution	1
3.0	**Group Dynamics**	
3.1	Definition and Meaning	1
3.2	Difference between Group and Team Groups in Organization, Team Effectiveness model	1
3.3	Dysfunction of groups and teams -Troubles with team	1

3.4	Social loafing – law of requisite variety- Ashby theory	2
4.0	**Organizational Culture**	
4.1	Meaning and Definition, Characteristics of Organizational culture	1
4.2	Elements of Organizational culture	1
4.3	Organizational sub culture, Artifacts for Organizational culture, Bicultural audit	1
4.4	Strategies to merger different organizational culture	2
5.0	**Organizational Change**	
5.1	Meaning, Need for change	1
5.2	Factors of Organizational change, Lewin's forced field model	1
5.3	Human reactions to change, Organization - Control, review and updating	1
5.4	Strategies for reducing change, Resistance to change	1
5.5	Ethical issues in Organizational change	1
6.0	**Case Studies**	2
	Total Periods	**48**

Course Contents and Lecture Schedule

esigners:

Dr. G.Chitra gcciv@tce.edu

14CERHO	CONSTRUCTION EQUIPMENT MANAGEMENT	Category	L	T	P	Credit
		PE	2	2	0	3

Preamble

Selection of appropriate equipment based on the requirements of project is crucial for completion of project at optimal cost and time. The mistakes during selection of equipment for any construction can be avoided by scheduling and optimising the construction equipment system productivity and making proper equipment financing decisions. This can be accomplished by understanding cost and life of equipment and its maintenance.

Prerequisite

Nil

Course Outcomes

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

		Expected Attainment Level (%)	Expected Proficiency Level (grade)
CO1 Explain the significance of equipment management in construction	**Understand**	70	A
(CO2) Estimate various cost components of equipment in relation to its life cycle.	**Apply**	70	
(CO3) Choose an appropriate equipment for a specific purpose	**Apply**	70	
(CO4) Estimate and Optimize equipment system productivity	**Apply**	70	
(CO5) Analyse the projects and identify the suitable equipment	**Analyze**	70	
(CO6) Compare and contrast various financing decisions for equipment purchase, operation and maintenance	**Apply**	70	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO_1	PSO_2
CO37.	-	-	-	L	-	L	-	S	S	L	L	-	L	L
CO38.	S	L	-	M	-	-	-	-	-	L	-	S	M	M
CO3.	M	L	-	M	-	M	-	-	L	S	L	-	M	M
CO4.	M	L	M	M	-	-	-	-	-	L	-	M	M	M
CO5.	M	M	M	S	-	S	-	L	S	L	M	M	M	M
CO6.	S	M	M	L	-	L	-	-	S	S	M	S	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	60	20	20	20
Apply	40	40	40	40
Analyse	0	20	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

95. Identify the role of heavy equipment in construction.
96. Discuss the development of earth moving and excavating equipment.
97. List the various and equipment and tool used in construction.

Course Outcome 2 (CO2):

98. List the constituents of ownership cost.
99. Compare the depreciation in each year of the equipment's useful life for each of the above depreciation methods for the following wheeled front-end bucket loader:
    - Initial cost: Rs.148,000 includes delivery and other costs
    - Tire cost: Rs.16,000
    - Useful life: 7 years
    - Salvage value: Rs.18,000
100. Estimate the hourly repair cost of the scraper in Example 2.3 for the second year of operation. The initial cost of the scraper is Rs. 1,86,000, tire cost Rs.14,000, and its useful life is 5 years. Assume average operating condition and 2000 h of operation per year.

Course Outcome 3 (CO3):

101. Report the conditions in which choice of front shovel for earthwork is suitable.
102. Discuss the various activities for which a dozer can be used.
103. Explain fork lifts.

Course Outcome 4 (CO4):

1. An 18–cubic yard dump truck has a loading time of 3 min, a travel time of 7 min, and the dumping and delay times of 5 min. Calculate the cycle time, optimum number of hauling units, and productivity.
2. List the assumptions in Peurifoy's method.
3. Compare Peurifoy's method with Phelp's method.

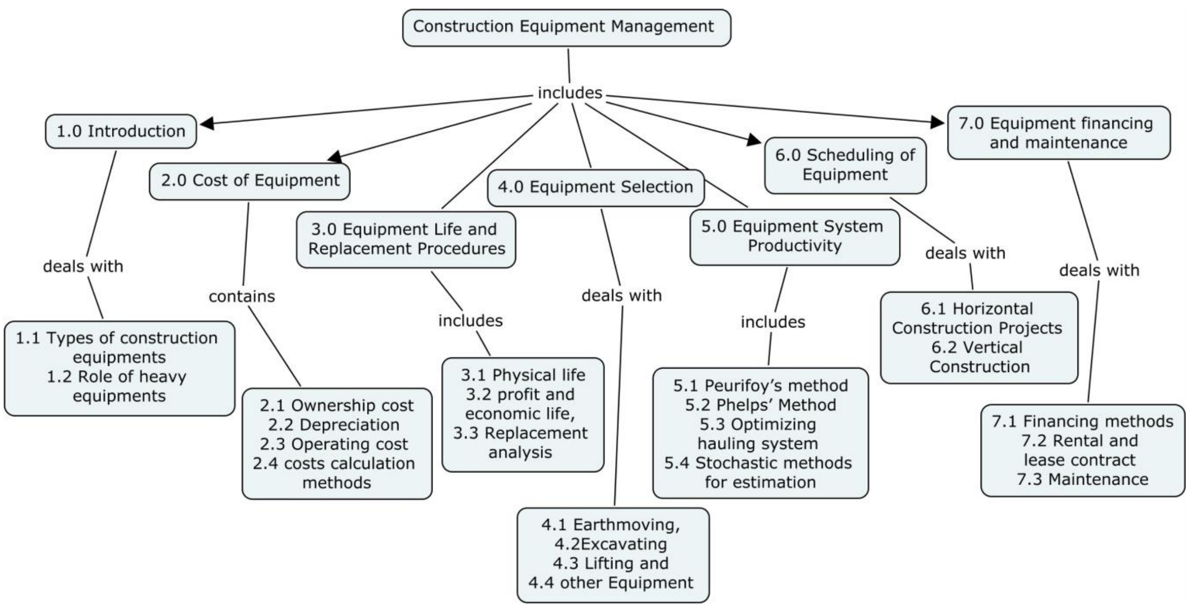
Course Outcome 5 (CO5):

104. Discuss the equipments for Vertical construction.
105. A free standing, top slewing, standard configuration, two-part standard line Liebherr tower crane secured in a concrete foundation base is hoisting a 1.75 cy bucket to pour concrete columns on a high-rise office building. The pour is a 10th floor column. Each floor is about 110600 floor surface to floor surface. The top of this column form is 60 off the 10th floor surface. The crane capacity is verified for the lifting radius of 900 and the setup. Arrive at the hourly production rate for the concrete to make this pour.
106. Describe linear scheduling method.

Course Outcome 6 (CO6):

107. Explain the significance of a maintenance program
108. Describe equipment renting and the conditions for adopting the same.
109. Prepare a list of factors making lease an attractive option for financing.

Concept Map



Syllabus

Role of Heavy Equipment in Construction; **Cost of Owning and Operating Construction Equipment** - Ownership cost, Depreciation, Operating cost, and Ownership and operating costs calculation methods; **Equipment Life and Replacement Procedures** - Physical, profit and economic life, Replacement analysis and selection; **Earthmoving, Excavating Lifting and other Equipment Selection** - Bulldozers, Front-end Loaders, Scrapers, Trucks, Excavators, Backhoes, Front shovels, Cranes, and Forklifts; Piles and Pile-Driving Equipment; Production of Crushed-stone Aggregate; Concreting Equipment; Asphalt Mix Production and Placement - Asphalt Plants, and Paving Equipment; **Estimating and Optimizing Construction Equipment System Productivity** - Peurifoy's method of optimizing productivity, Phelps' Method, Optimizing hauling system based on loading facility, Stochastic methods for estimation of productivity; **Scheduling Equipment Intensive Horizontal Construction Projects** - Linear scheduling method, Precedence diagramming method, Developing equipment resource packages; **Scheduling Lifting Equipment for Vertical Construction**; **Equipment Financing Decision**s – Fundamental Concepts of Equipment economics - Financing methods, Rental and lease contract considerations, **Construction Equipment Maintenance.**

References

1. Gransberg, D.G., Popescu, C. M., and Ryan, R. C., "Construction equipment management for engineers, estimators, and owners", Taylor & Francis, New York, 2006.
2. Peurifoy, R. L., Schexnayder, C. J., Shapira, A., and Schmitt, R., "Construction planning, equipment, and methods", 8th ed., McGraw Hill, New York, 2010.
3. Day, D. A. and. Benjamin, N. B. H., "Construction equipment guide", 2nd edition, Wiley Publications, New Jersey, 1991.
4. Harris, F., "Modern construction and ground engineering equipment and methods", 2nd edition, Longman, London, 1994.
5. Singh, J., "Heavy construction - planning, equipment and methods", 3rd edition, CRC Press, 2009.
6. Sharma S.C., "Construction equipment and management, Khanna Publishers, New Delhi, 2011.
7. Ministry of Rural Development, GOI, "Procurement Manual", National Rural Livelihoods Project, 2010
8. Peter Holm Andreasen, "Dynamics of Procurement Management – A Complexity Approach", Copenhagen Business School, 2012
9. Peter Baily, David Farmer, Barry Crocker, David Jessop & David Jones, "Procurement Principles and Management", FT Prentice Hall, 2010

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Introduction**	
1.1	Role of Heavy Equipment in Construction	1
2	**Cost of Owning and Operating Construction Equipment**	
2.1	Ownership cost – depreciation cost	1
	Tutorials	1
2.2	Cost of operating construction equipment	1
	Tutorials	1
2.3	Methods of calculating ownership and operation cost – Corps	1

Module No.	Topic	No. of Lectures
	of engineers method, AGC method, Peurifoy method	
	Tutorials	1
3	**Equipment Life and Replacement Procedures**	
3.1	Equipment life – Physical life, Profit life and Economic life	1
3.2	Replacement Analysis - Theoretical methods, Practical methods, and sensitivity analysis	
	Tutorials	1
3.3	Replacement equipment selection	1
4	**Earthmoving, Excavating Lifting and other Equipment Selection**	
4.1	Earthmoving Equipment Selection - Bulldozers, Front-end Loaders, Scrapers, Trucks	1
4.2	Excavating Equipment Selection - Excavators, Backhoes, Front shovels	1
4.3	Lifting Equipment Selection - Cranes, and Forklifts	1
4.4	Other Equipment - Piles and Pile Driving Equipment, Production of Crushed-stone Aggregate, Concreting Equipment, Asphalt Mix Production and Placement Equipment	2
5	**Estimating and Optimizing Construction Equipment System Productivity**	
5.1	Peurifoy's Method	1
	Tutorials	2
5.2	Phelps' Method	1
	Tutorials	3
5.3	Optimizing the Hauling System Based on Loading Facility Characteristics	1
	Tutorials	3
5.4	Stochastic Methods	1
	Tutorials	3
6	**Scheduling Equipment Intensive Horizontal Construction Projects**	
6.1	Linear scheduling method	1
6.2	Precedence diagramming method	
	Tutorials	3
6.3	Developing equipment resource packages	1
	Tutorials	3
7	**Scheduling Lifting Equipment for Vertical Construction**	
7.1	Scheduling lifting for high rise work	1
7.2	Scheduling concrete placing cranes	
	Tutorials	3
8	**Equipment Financing Decisions**	
8.1	Fundamental concepts of equipment economics	1
8.2	Financing Methods	1
	Tutorials	3
8.3	Rental and lease contract considerations	1
	Tutorials	3
9	**Construction Equipment Maintenance**	
9.1	Need for a maintenance program	1
9.2	Designing a Maintenance Program	1
9.3	Preventive and predictive maintenance	1
	Total Hours	**48**

Course Designers:

Dr. G.Chitra gcciv@tce.edu

14CERK0	MANAGEMENT OF HUMAN RESOURCES, SAFETY AND QUALITY	Category	L	T	P	Credit
		PE	4	0	0	4

Preamble

To impart knowledge on management of human resources, labour legislation, safety and quality aspects in construction.

Course Outcomes

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

		Expected Attainment Level (%)	Expected Proficiency Level (grade)
(CO1) Identify the need and importance ofhuman resource management, labour laws relating to construction industry	Understand	70	A
(CO2) Explain labour laws relating to construction industry	Understand	70	A
(CO3) Identify the types and causes of accidents in construction sites	Understand	70	A

(CO4) Identify the need and measures to improve safety in construction industry and safety audit	**Apply**	70	
(CO5) Identify the need for applying ergonomics to construction industry	**Apply**	70	
(CO6) Enumerate the need, importance, elements of quality and significance of quaity assurance in industry	**Apply**	70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO_1	PSO_2
CO39	--	M	L	--	--	M	S	M	S	S	L	--	-	L
CO40	L	S	M	M	--	S	S	M	M	S	M	L	M	L
CO3	L	S	M	M	--	S	S	M	M	S	M	L	M	L
CO4	M	S	M	L	--	S	S	--	--	--	S	--	M	S
CO5	M	S	M	M	--	L	M	S	M	S	S	L	L	M
CO6	M	S	M	M	--	L	M	S	M	S	S	L	L	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	50	40	40	40
Apply	30	40	40	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. With more women in the work force, what would be the major changes introduced into our society? Discuss
2. Discuss the challenges faced by modern personnel management
3. With the educational level of the nation's work force steadily increasing, discuss the problems and opportunities created for the personnel manager

Course Outcome 2 (CO2):

1. As a safety inspector, discuss the parameters you would look for, while auditing an industry for safety. Justify
2. Mention two measures by which fire at sites can be prevented
3. Discuss the various causes mentioning its effects and measures to minimize accidents in infrastructure industry

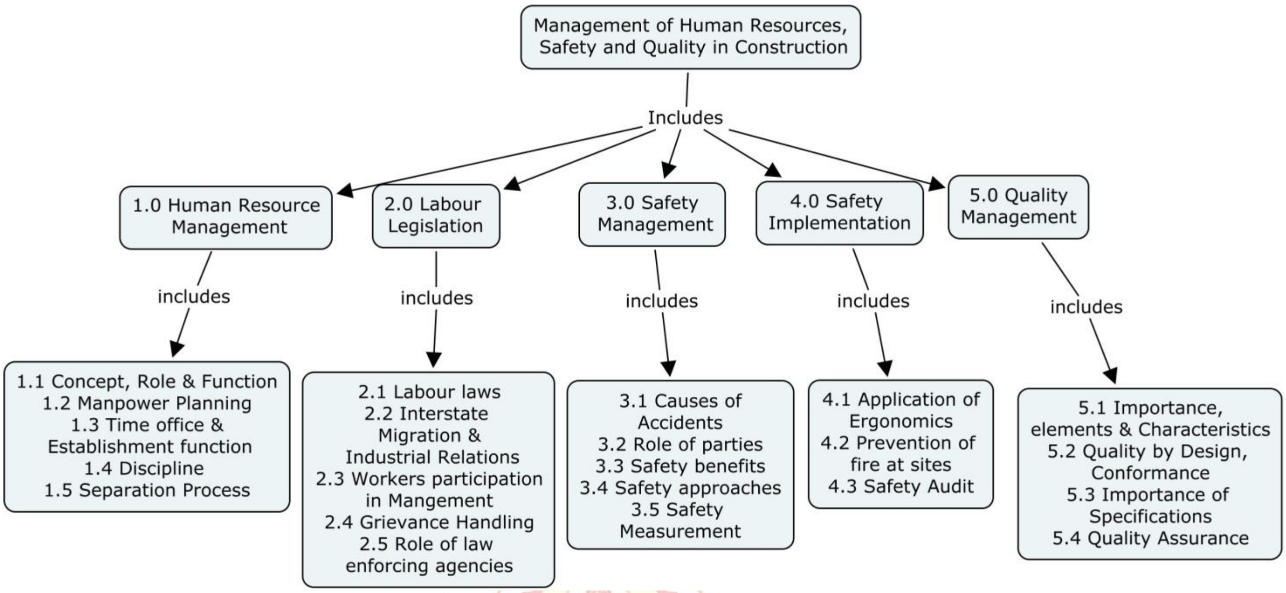
Course Outcome 3 (CO3):

1. Define the term ergonomics
2. Discuss the best practices of ergonomics in construction industry
3. As a HR manager of a firm discuss the schemes you would implement for your labour to work in harmony

Course Outcome 4 (CO4):

1. "Quality improves performance of an industry". Discuss and comment on this statement
2. Define quality assurance. Discuss its various components
3. Define the term quality and mention its need in infrastructure industry

Concept Map



Syllabus

Human Resources Management- Introduction – Concept- Growth – Role and function. Manpower Planning for Construction Companies – Line and Staff function. Recruitment, selection, placement, induction and training; over staffing; Time office and establishment functions; wage and salary administration – Discipline- Separation Process. **Labour Legislation**- Labour laws - labour law relating to construction industry- Interstate migration- Industrial relations- Collective bargaining- Worker's participation in management. Grievance handling- discipline-role of law enforcing agencies and judiciary – women in construction industry. **Safety Management-** importance of safety- causes of accidents – responsibility for safety –Role of various parties in safety management – safety benefits- approaches to improve safety in construction for different works- measuring safety. **Safety Implementation -** Application of Ergonomics to the construction industry- prevention of fires at construction site- Safety audit. **Quality Management in Construction**- Importance of quality; Elements of quality- quality characteristics- quality by design - quality conformance, contractor quality control- identification and traceability, Continuous Chain Management – brief concept and application. Importance of specifications- Incentives and penalties in specifications – Workmanship as a mark of quality – Final Inspection. Quality assurance techniques – Inspection, testing, sampling. Documentation – Organization for quality control, Cost of quality. Introduction to TQM, Six Sigma Concept

Reference Books

1. **Arya Ashok, "Human Resources Management – Human Dimensions in Management" March 24-26, 2011, Organizational Development Programme Division – New Delhi**
2. **Arya Ashok, "Essence of Labour Laws"- www.odiindia.in/about-the-books.pdf**

3. Arya Ashok "Discipline & Disciplinary procedure" Organisation Development Institute, 1998
4. Arya Ashok, "Management case studies – An analytical and Developmental Tool" Organisation Development Institute, New Delhi, 1999
5. Corlecton Coulter, Jill Justice Coulter, The Complete Standard Hand Book of Construction Management", Prentice Hall, (1989)
6. Dwivedi R.S., "Human Relations and Organisational Behaviour", (BH – 1987)
7. Grant E.L., and Leavens worth, "Statistical Quality Control", Mc Graw Hill, 1984.
8. James J Obrien, "Construction Inspection Hand Book – Quality Assurance and Quality Control", Van NOstrand, New York, 1989
9. Josy J. Farrilaro, "Hand Book of Human Resources Administration" Mc.Graw Hill (International Edition) 1987.
10. Juran Frank, J.M. and Gryna F.M. "Quality Planning and Analysis", Tata Mc Graw Hill, 1982.
11. Malik, P.L., "Handbook of Labour & Industrial Law", Eastern book company, Lalbagh, Lucknow, 2010
12. Manoria C.B., "Personnel Management", Himalaya Publishing House, 1992.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	**Human Resources Management**	
1.1	Introduction – Concept- Growth – Role and function	2
1.2	Manpower Planning for Construction Companies– Line and Staff function. Recruitment, selection, placement, induction and training; over staffing	2
1.3	Time office and establishment functions; wage and salary administration	2
1.4	HRM - Discipline	2
1.5	HRM - Separation Process	2
2.0	**Labour Legislation**	
2.1	Labour laws- labour law relating to construction industry	2
2.2	Interstate migration- Industrial relations -Collective bargaining	2
2.3	Worker's participation in management	2
2.4	Grievance handling - discipline	2
2.5	Role of law enforcing agencies and judiciary – women in construction industry	2
3.0	**Safety Management**	
3.1	Importance of safety- causes of accidents – responsibility for safety	2
3.2	Role of various parties in safety management	2
3.3	Safety benefits	2

3.4	Approaches to improve safety in construction for different works	3
3.5	Safety Measurement, Safety standards	2
4.0	**Safety Implementation**	
4.1	Application of Ergonomics to the construction industry	3
4.2	Prevention of fires at construction site, Site safety planning	2
4.3	Safety audit	2
5.0	**Quality Management in Construction**	
5.1	Importance of quality; Elements of quality- quality characteristics, Quality control in construction- identification and traceability, Continuous Chain Management – brief concept and application	3
5.2	Quality by design- quality conformance, contractor quality control	3
5.3	Importance of specifications- Incentives and penalties in specifications – Workmanship as a mark of quality – Final Inspection	2
5.4	Quality assurance techniques – Inspection, testing, sampling Documentation – Organization for quality control, Cost of quality, Introduction to TQM, Six Sigma Concept	2
	Total Periods	**48**

esigners:

gcciv@tce.edu

Dr. G.Chitra

SIXTH SEMESTER

Course code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14CE610	Design of RC Elements	PC	2	2	-	3
14CE620	Railways, Airways and Waterways	PC	3	-	-	3
14CE630	Foundation Engineering	PC	2	2	-	3
14CE640	Irrigation and Water Resources Engg.	PC	2	-	-	2
14CE670	Design of Steel Structures	PC	2	2	-	3
14CEPX0	Programme Elective	PE	3	-	-	3
14CEGX0	General Elective	GE	3	-	-	3
THEORY CUM PRACTICAL						
PRACTICAL						
14CE680	Soil and Highway Engg Lab	PC	-	-	2	1
	Total		**16**	**6**	**4**	**21**

*** BS- Basic Sciences; HSS-Humanities and Social Sciences; ES-Engineering Sciences; PC- Programme Core; PE-Programme Elective; GE-General Elective; OC-One Credit Course; TC- Two Credit Course; GS- Guided Study Course (in the list of Programme Electives)*

Note:

1 Hour Lecture is equivalent to 1 credit

2 Hours Tutorial is equivalent to 1 credit

2/3 Hours Practical is equivalent to 1 credit

SIXTH SEMESTER

S.No.	Sub. Code	Name of the subject	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	14CE610	Design of RC Elements	3	50	50	100	25	50
2	14CE620	Railways, Airways and Waterways	3	50	50	100	25	50
3	14CE630	Foundation Engineering	3	50	50	100	25	50
4	14CE640	Irrigation and Water Resources Engg.	3	50	50	100	25	50
5	14CE670	Design of Steel Structures	3	50	50	100	25	50
6	14CEPX0	Programme Elective	3	50	50	100	25	50
7	14CEGX0	General Elective	3	50	50	100	25	50
PRACTICAL								
8	14CE680	Soil and Highway Engg Lab	3	50	50	100	25	50

* Continuous Assessment evaluation pattern will differ from subject to subject and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

** Terminal Examination will be conducted for maximum marks of 100 and subsequently be reduced to 50 marks for the award of terminal examination marks.

SEVENTH SEMESTER

Course code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14CE710	Accounting and Finance	HSS	2	2	-	3
14CE720	Project Management	PC	2	2	-	3
14CEPX0	Programme Elective I	PE	3	-	-	3
14CEPX0	Programme Elective II	PE	3	-	-	3
14CEGX0	General Elective	GE	3	-	-	3
14CE770	Design of RC Structures	PC	2	2	-	3
14CE7C0	Capstone Course II	PC	2	-	-	2
PRACTICAL						
14CE780	Estimation and Costing Lab	PC	-	-	2	1
Total			**17**	**6**	**2**	**21**

*** BS- Basic Sciences; HSS-Humanities and Social Sciences; ES-Engineering Sciences; PC- Programme Core; PE-Programme Elective; GE-General Elective; OC-One Credit Course; TC- Two Credit Course; GS- Guided Study Course (in the list of Programme Electives)*

Note:

1 Hour Lecture is equivalent to 1 credit

2 Hours Tutorial is equivalent to 1 credit

2/3 Hours Practical is equivalent to 1 credit

SEVENTH SEMESTER

S.No.	Sub. Code	Name of the subject	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	14CE710	Accounting and Finance	3	50	50	100	25	50
2	14CE720	Project Management	3	50	50	100	25	50
3	14CEPX0	Programme Elective **I**	3	50	50	100	25	50
4	14CEPX0	Programme Elective **II**	3	50	50	100	25	50
5	14CEGX0	General Elective	3	50	50	100	25	50
6	14CE770	Design of RC Structures	3	50	50	100	25	50
PRACTICAL								
7	14CE780	Estimation and Costing Lab	3	50	50	100	25	50

* Continuous Assessment evaluation pattern will differ from subject to subject and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

** Terminal Examination will be conducted for maximum marks of 100 and subsequently be reduced to 50 marks for the award of terminal examination marks.

EIGHTH SEMESTER

Course code	Name of the Course	Category	No. of Hours / Week			credits
			L	T	P	
14CEPX0	Programme Elective I	PE	3	-	-	3
14CEPX0	Programme Elective II	PE	3	-	-	3
14CEPX0	Programme Elective III	PE	3	-	-	3
14CE880	Project	PC	-	-	24	12
PRACTICAL						
	Total		**9**	**-**	**24**	**21**

EIGHTH SEMESTER

S. No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	14CE880	Project	-	100	100	300	75	100

* Continuous Assessment evaluation pattern will differ from subject to subject and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

** Terminal Examination will be conducted for maximum marks of 300 and subsequently be reduced to 100 marks for the award of terminal examination marks.

SEM	Theory						Theory cum Practical	Practical		Special Courses	Credits
	1	2	3	4	5	6	7	8	9	10	
I	Common to All Branches										21
II	14CE210 Engineering Mathematics II (3)	14CE220 Strength of Materials (3)	14CE230 Surveying (3)	14CE240 Engineering Geology (3)	14CE250 Environmental Science (3)	---	14CE270 Building Material and Technology (Theory Cum Practical) (3)	14CE280 Survey lab –I (1)	14CE290 Workshop (1)	---	20
III	14CE310 Fourier Series & Partial Diff. Eqns. III (3)	14CE321 Mechanics of solids (3)	14CE330 Fluid Mechanics (3)	14CE340 Water Supply Engineering (3)	14CE351 Concrete Technology (3)	14CE360 Problem solving using Computer (3)	---	14CE380 CAD (1)	14CE390 Survey lab – II (1)	---	20
IV	14CE410 Mathematics IV (3)	14CE420 Structural Analysis (3)	14CE430 Hydraulics and Hydraulic Machinery (3)	14CE440 Wastewater Engineering (3)	14CE450 Engineering Design (3)	---	14CE470 Professional Communication (Theory Cum Practical) (2)	14CE480 Computer programming lab (1)	14CE490 Fluid Mechanics & Machinery lab (1)	14CE4C1 Capstone Course I (2)	21
V	14CE510 Mathematics V (3)	14CE520 Engineering Hydrology (2)	14CE530 Soil Mechanics (3)	14CE540 Highway and Pavement Engineering (3)	14CEPX0 Prog. Elect. I (3)	---	14CE570 Design of, Masonry, Timber and Steel Elements (3)	14CE580 Materials Testing lab (1)	14CE590 Environmental Engineering lab (1)	---	19
VI	14CE610 Design of RC Elements (3)	14CE620 Railways, Airways and Waterways (3)	14CE630 Foundation Engineering (3)	14CE640 Irrigation and water Resources Engineering (2)	14CEPX0 Prog. Elect. II (3)	14CEGX0 Gen. Elect. (3)	14CE670 Design of Steel Structures (3)	14CE680 Soil and Highway Engg lab (1)	---	---	21
VII	14CE710 Accounting and finance (3)	14CE720 Project Management (3)	14CEPX0 Prog. Elect. III (3)	14CEPX0 Prog. Elect. IV (3)	14CEGX0 Gen. Elect. (3)	---	14CE770 Design of RC Structures (3)	14CE780 Estimation and Costing (1)	---	14CE7C0 Capstone Course II (2)	21
VIII	14CEPX0 Prog. Elect. V (3)	14CEPX0 Prog. Elect. VI (3)	14CEPX0 Prog. Elect. VII (3)	---	---	---	---	14CE880 Project (12)		---	21

14CEGA0	SUSTAINABLE DEVELOPMENT	Category	L	T	P	Credit
		GE	3	0	0	3

Preamble

This coursework covers the concept of sustainable development in the context of various environmental components and its interaction with human development.

Prerequisite

Nil

Course outcome

	On the successful completion of the course, students will be able to		Expected Attainment Level (%)	Expected Proficiency Level (grade)
CO1	Understand the concepts of Sustainable Development.	Understand	70	A
CO2	Analyze the sustainability in environmental components	Understand	70	A
CO3	Identify the drivers and processes towards attaining sustainability	Understand	80	A
CO4	Measure the sustainability through performance indicators	Apply	70	A
CO5	Understand the international protocols and commitments towards sustainability	Understand	70	A
CO6	Develop strategies to achieve sustainable Development	Apply	70	A

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO41	M	L	-	-	-	M	S	M	M	L	L	-
CO42	M	M	M	-	-	L	S	M	M	M	L	M
CO3	M	S	M	L	-	L	S	M	L	L	-	-
CO4	S	L	M	-	-	L	S	L	L	L	-	-
CO5	L	M	-	-	-	M	S	M	L	M	-	-
CO6	M	M	S	L	-	M	S	M	M	M	-	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	

Remember	**20**	**20**	**20**	**20**
Understand	**40**	**40**	**40**	**40**
Apply	**40**	**40**	**40**	**40**
Analyse	**-**	**-**	**-**	**-**
Evaluate	**-**	**-**	**-**	**-**
Create	**-**	**-**	**-**	**-**

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. **What are the principles of sustainable development?**
2. **Explain the different sources of indoor air pollutants.**
3. **Indoor air pollutant is different in rural and urban area-why?**

Course Outcome 2 (CO2)

1. **What will be the influence of ventilation in handling Indoor air pollution?**
2. Radon and its decay- explain with reference to Indoor air quality.
3. What is the significance of VOC in inducing indoor air pollution?

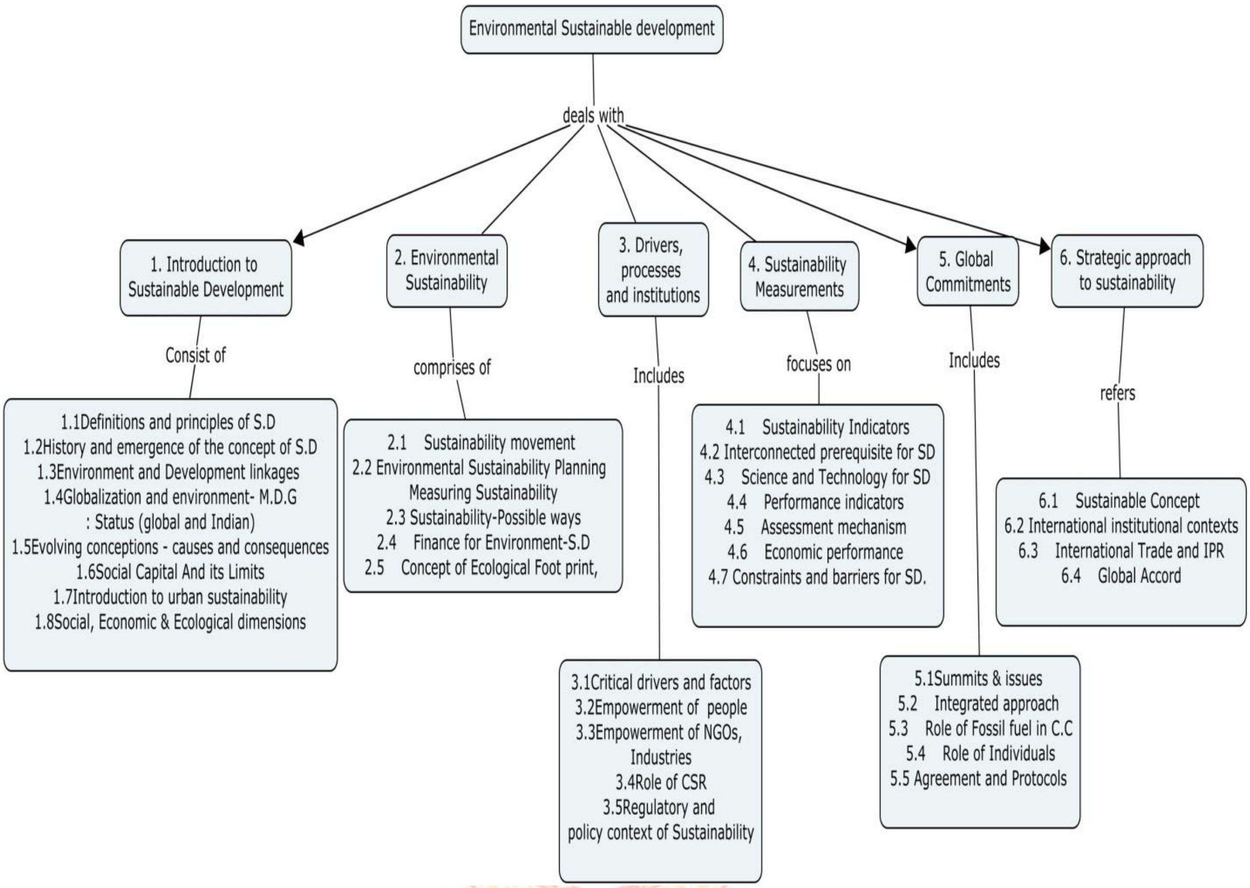
Course Outcome 3 (CO3)

1. **Formulate a statistical model for Indoor air pollution**
2. **Model Indoor air pollutant concentration using material balance.**
3. **Compare and contrast Statistical model with material balance model.**

Course Outcome 4 (CO4)

1. What are the generally adopted control technology for infectious disease transmission?
2. Comment on sick building syndrome and its control technique
3. What are special indoor environments?

Concept Map



Syllabus

Introduction to Sustainable Development: Definitions and principles, History and emergence of the concept of Sustainable Development, Environment and Development linkages, Globalization and environment- Millennium Development Goals, Evolving conceptions - causes and consequences, Social Capital And its Limits, Introduction to urban sustainabilityEcological dimensions **Environmental sustainability:**Land, Food, Water and Energy sustainability, Measuring Sustainability, Carrying Capacity And its Limits, Finance for Environment , Concept of Ecological Foot print;**Drivers, processes and institutions:**Critical drivers, social mechanisms and cognitive factors, Empowerment of stakeholders, Role of Corporate Social Responsibility, Regulatory and policy context of Sustainability;**Sustainability measurements**Indicators – guidelines; Interconnected prerequisite for Sustainable development, Science and Technology for Sustainable development, Performance indicators of Sustainability, Assessment mechanism ofEconomic performance - production and consumption, Constraints and barriers for sustainable development; **Global commitments:**International Summits and Trans boundary issues,Integrated approach for resource protection and management,Role of Fossil fuel in Climate Change- future use of renewable energy, Role of Governments, Industries and Individuals, International agreement and Protocols;**Strategic approach to sustainability-**Sustainable Concept measurement strategies, From sustainability 'Problems' to 'Solution' strategies, New international institutional contexts, International Trade and IPR, Global Accord.

Text Book

1. OECD INSIGHTS,Sustainable Development- linking economy, society, environment , Tracey Strange, Anne Bayley.

Reference Book

1. Environmental Concerns and Sustainable development: Some perspectives from India,Editors: GaneshaSomayaji and SakaramaSomayaji, publisher TERI Press, ISBN 8179932249.
2. “Achieving Broad-Based Sustainable Development: Governance, Environment, and Growth with Equity” James H. Weaver, Michael T. Rock, Kenneth Kustere. Kumarian Press, West Hartford, CT. Publication Year: 1997
3. “Sustainable development” Kirkby. J, O’Keefe P. and Timberlake, Earth Scan Publication, London, 1996.
4. Sustainable Environmental Management: Principles and Practice by R. Kerry Turner. 292 pgs. Publisher: Belhaven Press, ISBN:1852930039.
5. “Introduction to Sustainability”, N. Munier ,Springer 2005

Lecture schedule

Module No	Topics	No of Lectures
1. Introduction to Sustainable Development		
1.1	Definitions and principles of Sustainable Development	1
1.2	History and emergence of the concept of Sustainable Development	1
1.3	Environment and Development linkages	1
1.4	Globalization and environment- Millennium Development Goals: Status (global and Indian)	1
1.5	Evolving conceptions - causes and consequences	1
1.6	Social Capital And its Limits	1
1.7	Introduction to urban sustainability	1
1.8	Social dimensions, Economic dimensions, Ecological dimensions	1
2. Environmental Sustainability		
2.1	Sustainability movement towards Land, Food, Water and Energy	1
2.2	Environmental Sustainability Planning Measuring Sustainability - Carrying Capacity And its Limits	1
2.3	Moving towards Sustainability-Possible ways	1
2.4	Finance for Environment-Sustainable development	1
2.5	Concept of Ecological Foot print,	1
3. Drivers, processes and institutions		
3.1	Critical drivers, social mechanisms and cognitive factors	1
3.2	Empowerment of women, Children, Youth, Indigenous people	1
3.3	Empowerment of NGOs, Local authorities, Industries	1
3.4	Role of Corporate Social Responsibility	1
3.5	Regulatory and policy context of Sustainability	1
4. Sustainability Measurements		
4.1	Sustainability Indicators - Operational guidelines	1
4.2	Interconnected prerequisite for Sustainable development	1
4.3	Science and Technology for Sustainable developments	1

4.4	Performance indicators of Sustainability	1
4.5	Assessment mechanism – Carbon Foot print calculator by spreadsheet	1
4.6	Economic performance - production and consumption	1
4.7	Constraints and barriers for sustainable development.	1
5. Global Commitments		
5.1	International Summits and Trans boundary issues	1
5.2	Integrated approach for resource protection and management	1
5.3	Role of Fossil fuel in Climate Change- future use of renewable energy	1
5.4	Role of Governments, Industries and Individuals	1
5.5	International agreement and Protocols	1
6. Strategic approach to sustainability		
6.1	Sustainable Concept measurement strategies	2
6.2	From sustainability 'Problems' to 'Solution' strategies	1
6.3	New international institutional contexts	1
6.4	International Trade and IPR	1
6.5	Global Accord	1
	Total periods	**36**

Course designers

Dr.T. Velrajan tvciv@tce.edu
Dr.S. Chandranschandran@tce.edu

14CEGB0	BUILDING SERVICES	Category	L	T	P	Credit
		GE	3	0	0	3

Preamble

This course work imparts knowledge required for understanding the general principles of building planning and services with the help of relevant codes, manuals and guidelines.

Prerequisite

Nil

Course Outcomes

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

			Expected Attainment Level (%)	Expected Proficiency Level (grade)
CO1	Apply the general planning considerations and development control rules for different types of buildings.	Apply	70	A
CO2	Remember and Understand the Relevant code and manuals for designing of building services	Apply	70	A
CO3	Apply the principles of electrical and lighting services for different uses in buildings	Apply	70	A
CO4	Understand and apply the principles of plumbing services for domestic and industrial needs	Apply	70	A
CO5	Plan and design the requirements for HVAC systems, fire fighting and other necessary services for a various types buildings	Apply	70	A
CO6	Incorporate the integrated planning and designing of necessary building services for better usage of buildings	Apply	70	A

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO43.	L	L	-	-	-	M	M	S	L	L	-	-
CO44.	L	L	-	-	-	M	M	M	M	L	-	L
CO3	M	M	S	L	-	M	M	M	L	M	-	L
CO4	M	M	S	L	-	M	M	M	L	M	-	L
CO5	M	M	S	L	-	M	M	M	L	M	-	L
CO6	M	S	S	S	-	M	S	M	M	M	-	M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	**20**	**20**	**20**	**20**
Understand	**50**	**50**	**50**	**40**
Apply	**30**	**30**	**30**	**40**

Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1)

4. List the types of land use according to Building Development Control Rules
5. Discuss the regulations with respect to fire safety in buildings
6. Discuss the planning considerations to be made in buildings based on codal provisions on fire safety

Course Outcome 2 (CO2)

4. Explain the need and details of earthing to a building as per IS specifications
5. Specify the minimum levels of illumination for different buildings as per NBC
6. Discuss the various water conservation measures applied to an Educational Institute with hostel facility?

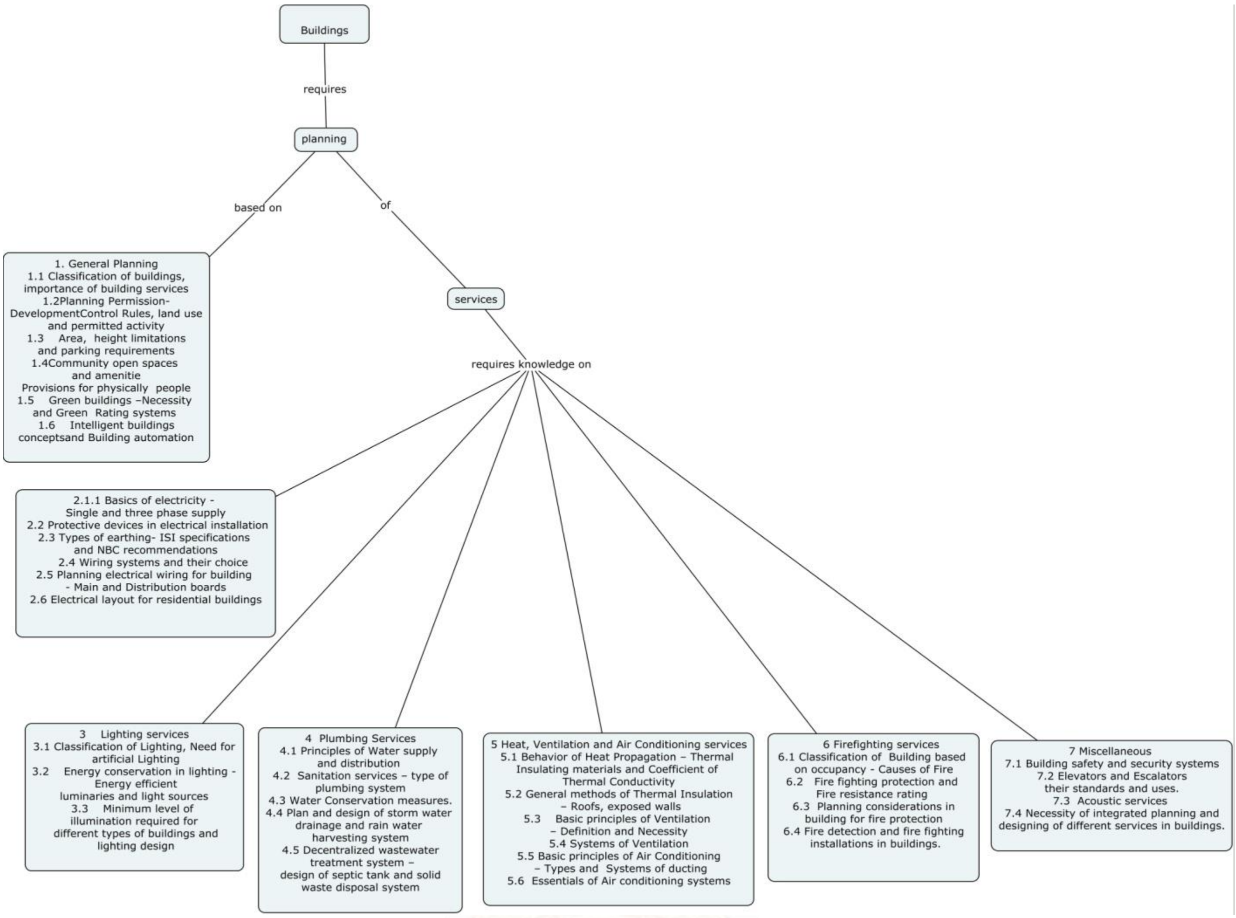
Course Outcome 3 (CO3)

4. Assume an IT building is to be constructed in a metropolitan area of 20,000 sq.m. The width of road in front is 15 m. Plan the building according to F.S.I and height restrictions. Justify your recommendations
5. Select a suitable wiring system for a building having a connected load of 500kW. Make suitable assumptions. Justify your selection
6. Suggest suitable fire fighting installations needed for a commercial complex building of 4 floors

Course Outcome 4 (CO4)

4. Discuss the regulations with respect to fire safety in buildings
5. Discuss the planning considerations to be made in buildings based on codal provisions on fire safety
6. Plan and draw an electrical layout for a residential building considering the essential electrical points in various rooms

Concept Map



Syllabus

General Planning:– classifications of buildings, Planning permissions, permitted activity, Area and height limitations, Community open spaces and amenities .- Green buildings-Intelligent buildings **Electrical Systems and Installations:** Basics of electricity – Single and three phase supply- Protective devices in electrical installation – types of earthing ,Planning electrical wiring for building-Electrical layout for residential buildings**Lighting services:** Classification of Lighting, -Energy conservation in lighting-Minimum level of illumination required for different types of buildings. **Plumbing Services:** Principles of Water supply and distribution, Sanitation in buildings , Water Conservation measures – Plan and design of storm water drainage and rain water harvesting system. –Decentralized wastewater treatment system.**HVAC** -Behavior of Heat Propagation, General methods of Thermal Insulation- Basic principles of Ventilation-Systems of ventilation,Basic principles and essentials of Air Conditioning**Firefighting services:**Classification of buildings based on occupancy- fire fighting protection and fire resistance rating ,planning considerations in building for Fire protection-fire detection and fire fighting installation in buildings.. **Miscellaneous:** Building safety and security systems - Elevators and Escalators their standards and uses - Acoustic services - Necessity of integrated planning and designing of different services in buildings.

Text Book

2. National Building Code of India -2005

Reference Book

5. Development Control Rules by Chennai Metropolitan Development Agency - 2006
6. Energy Conservation Building Code – 2007
7. CPHEEO Manual on Sewerage and sewage treatment systems – 2013
8. Manual for environmental clearance for large construction projects – by Ministry of environment , forest and climate change.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	**General Planning**	
1.1	Classification of buildings, importance of building services	1
1.2	Planning Permission- Development Control Rules, land use classificationsand permitted activity	1
1.3	Area, height limitations and parking requirements	1
1.4	Community open spaces and amenities - Provisions for physically challenged people	1
1.5	Green buildings –Necessity and Green Rating systems	1
1.6	Intelligent buildings concepts and Building management systems.	1
2.0	**Electrical Systems and Installations**	
2.1	Basics of electricity - Single and three phase supply	1
2.2	Protective devices in electrical installation	1
2.3	Types of earthing- ISI specifications and NBC recommendations	2
2.4	Wiring systems and their choice	1
2.5	Planning electrical wiring for building-Main and Distribution boards and energy ratings for appliances.	1
2.6	Electrical layout for residential buildings	1
3.0	**Lighting services**	
3.1	Classification of Lighting, Need for artificial Lighting	1
3.2	Energy conservation in lighting -Energy efficient luminaries and light sources	1
3.3	Minimum level of illumination required for different types of building- lighting design	1
4.0	**Plumbing Services**	
4.1	Principles of Water supply and distribution	1
4.2	Sanitation services – type of plumbing system	1
4.3	Water Conservation measures.	1
4.4	Plan and design of storm water drainage and rain water harvesting system	1
4.5	Decentralized wastewater treatment system – design of septic tank and solid waste disposal system	1
5.0	**Heat, Ventilation and Air Conditioning services**	
5.1	Behavior of Heat Propagation – Thermal Insulating materials and Coefficient of Thermal Conductivity	1

5.2	General methods of Thermal Insulation – Roofs, exposed walls	1
5.3	Basic principles of Ventilation – Definition and Necessity	1
5.4	Systems of Ventilation	1
5.5	Basic principles of Air Conditioning – Types and Systems of ducting	1
5.6	Essentials of Air conditioning systems	1
6.0	**Firefighting services**	
6.1	Classification of Building based on occupancy - Causes of Fire	1
6.2	Fire fighting protection and Fire resistance rating	1
6.3	Planning considerations in building for fire protection	1
6.4	Fire detection and fire fighting installations in buildings.	1
7.0	**Miscellaneous**	
7.1	Building safety and security systems	1
7.2	Elevators and Escalators their standards and uses.	1
7.3	Acoustic services and	1
7.4	Necessity of integrated planning and designing of different services in buildings and solid waste management options.	2
	TOTAL	**36**

Course designers

3. V. Ravisankar environmentengr@tce.edu
4. D. Rajkumar rajkumarcivil@tce.edu

14CEGC0 **DISASTER ASSESSMENT AND MITIGATION MEASURES**

Category	L	T	P	Credit
GE	3	0	0	3

Preamble

This course deals with the various disasters and to expose the students about the measures, its effect against built structures, and Hazard Assessment procedure in India. This course also deals with the methods of mitigating various hazards such that their impact on communities is reduced.

Course Outcomes

	At the end of the course the student will be able to		Expected Attainment Level (%)	Expected Proficiency Level (grade)
CO1	Understand the various types of disaster vizHydrological, Coastal and Marine Disasters, Atmospheric Disasters, Geological, Mass Movement and Land Disasters, Wind and Water Driven Disasters	Understand	70	A
CO2	To identify the potential deficiencies of existing buildings for Earthquake disaster and suggest suitable remedial measures.	Understand	70	A
CO3	Derive the guide lines for the precautionary measures and rehabilitation measures for Earthquake disaster.	Apply	70	A
CO4	Derive the protection measures against floods, cyclone, land slides	Apply	70	A
CO5	Understand the effects of disasters on built structures	Understand	70	A
CO6	Understand the hazard Assessment procedure	Understand	70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	M	-	-	-	-	-	-	-	-	-	-
CO2	L	M	-	-	-	-	-	-	-	-	-	-
CO3	S	S	M	L	-	-	-	-	-	-	-	-
CO4	S	S	M	L	-	-	-	-	-	-	-	-
CO5	L	M	-	-	-	-	-	-	-	-	-	-
CO6	L	M	-	-	-	-	-	-	-	-	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

S.No.	Bloom's Category	Test 1	Test 2	End semester Examination
1	Remember	20	20	20
2	Understand	80	60	60
3	Apply	0	20	20
4	Analyse	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Course Level Learning Objectives

Course Outcome (CO1)

5. What is Richter Magnitude?
6. What is Peak ground Acceleration?
7. What is meant by *hazard mitigation*?
8. What is a Local Hazard Mitigation Plan?

Course Outcome (CO2)

5. List the different types of droughts and highlight its various causes.
6. Define community Contingency Plan
7. How does the site soil affect the EQ response of structures?
8. Explain the classification and causes of landslides indicating the places where they could occur in India.

Course Outcome (CO3)

3. Explain the plan, Mass and Geometric irregularities in the RC buildings. How these irregularities adversely affect the performance of the RC buildings during Earthquake
4. Discuss the various types of natural disasters and highlight the specific efforts to mitigate disasters in India

Course Outcome (CO4)

3. Describe various types of hazards and impacts associated with earthquakes and highlight the lessons learnt

4. Briefly explain the components of follow-up activities in psychological rehabilitation of disaster affected people.

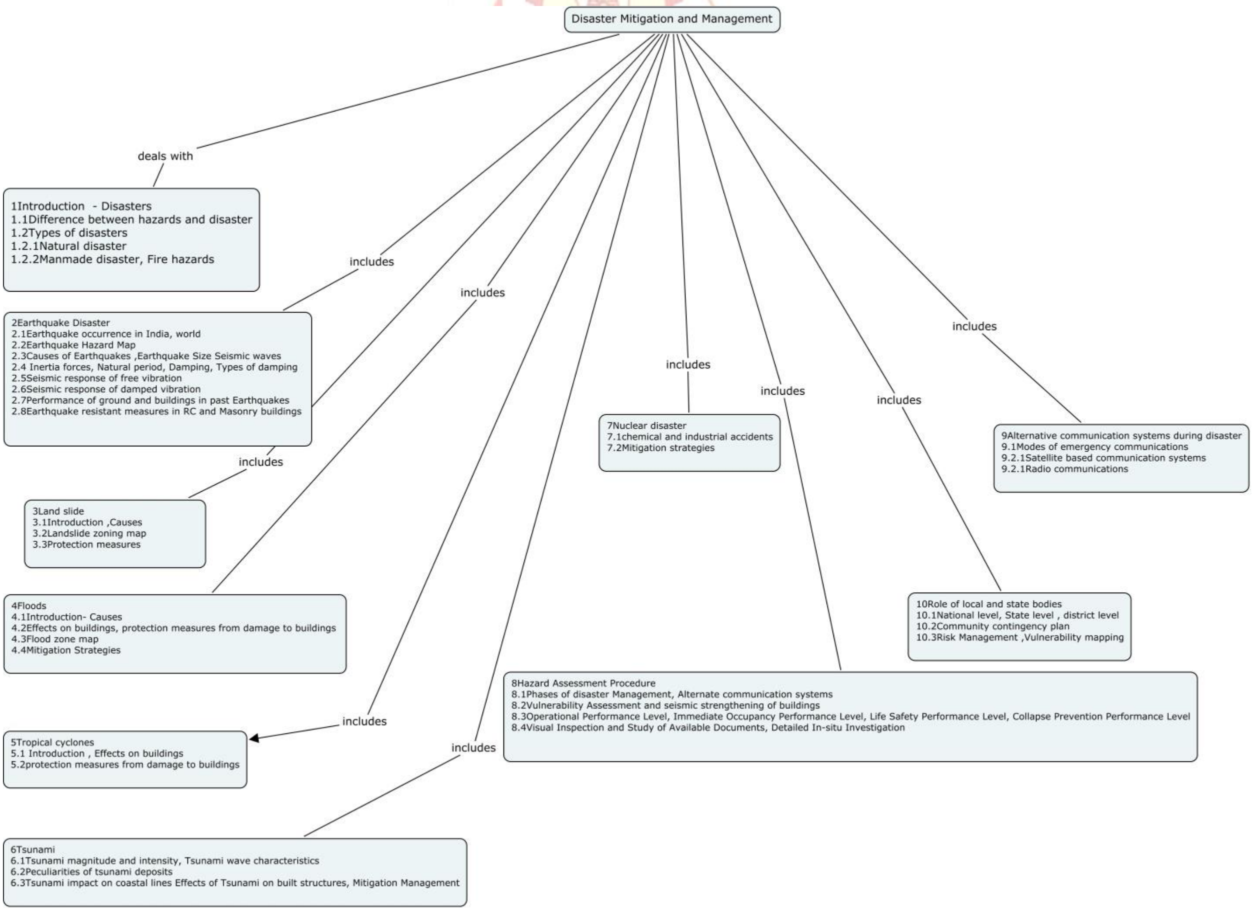
Course Outcome (CO5)

4. If you were the relief commissioner of the state of Assam which is affected by floods every year list out five departments that you need to contact.
5. Identify four different task forces and list out two responsibilities of each of the task forces
6. Do you think disaster risk can be reduced through community participation? Discuss

Course Outcome (CO6)

4. Which areas are more prone to heat and cold waves in India? Discuss the preventive and preparedness measures that are mostly adopted for protection from heat and cold waves
5. Explain the role of central Government in responding to disasters
6. Describe suitable mitigation and preparedness measures that the community should take in advance to guard a EQ disaster occurring again.

Concept Map



Course Content and Lecture Schedule

Module No.	Topics	No. of Lectures

1	**Introduction - Disaster**	
1.1	Over view of Disaster Management	1
2	**Land slide**	
2.1	Introduction ,Causes,types,preparation of hazard zonation map	1
2.2	Liquefaction -remedial options	1
2.3	Liquefaction related phenomena	1
2.4	Evaluation of Liquefaction hazards and Liquefaction resistance	1
2.5	Slope failures	1
3	**Floods**	
3.1	Introduction- Causes -Rescue and relief Management	1
3.2	Effects on buildings, protection measures from damage to buildings	1
3.3	Case studies	1
4	**Earthquake Disaster**	
4.1	Causes of Earthquakes ,Earthquake Size Seismic waves	1
4.2	Earthquake resistant measures in RC and Masonry buildings	1
4.3	Seismic response of free and forced damped vibration	1
5	**Tropical cyclones**	
5.1	Introduction , Effects on buildings,Warning systems in India	1
5.2	Damaging effects of cyclone	1
5.3	Design procedure for wind resistant buildings	1
6	**Tsunami**	
6.1	Tsunami causes ,Warning systems DART floatingbouys	1
6.2	Tsunami impact on coastal lines Effects of Tsunami on built structures	1
7	**Man made Disaster - Industrial accident case study**	1
7.1	NBC,Radioactivity,Alpha ,Beta , Gamma decay,fission and fusion	1
7.2	Chemical warfare agents,universal classification of hazard substances and explosives,decontamination procedure - BW agents -Emergency Medical responder,Vital signs (RPSPBP)	2
7.3	Classification of Hazardous chemicals	1

8	**CSSR -Collapsed Structure & Rescue operations**	
8.1	Search and rescue and evacuation methods	1
8.2	Fire safety technique classification Extiguishers	1
8.3	Life saving skills - Body mechanics - CPR - Burn and its classification	1
9	**Role and responsibility of NDRF**	1
9.1	Skill variety of NDRF Battalions-MFR-FRRM,CBRN disasters	1
9.2	START system,TRIAGE,FBAO(Foreign body airway Obstruction	1
9.3	Community training	1
10	**Hazard Assessment Procedure**	
10.1	DSHA - Case studies	1
10.2	PSHA - completeness analysis (step method),	1
10.3	seismic hazard curves,UHRS,GRA,	1
10.4	RVS,Push Over Analysis	1
10.5	Policy and procedures	1
10.6	Role of Local and state bodies,Alternate communication systems	1
10.7	Community planning Community Contingency plan	1
	Total Hours	**36**

Syllabus

Introduction -Introduction-Difference between hazards and disaster –Types of disasters-Phases of disaster Management -Hazards -Classification of Hazards - Hazards affecting buildings - Building safety against hazards –Floods – Cyclone – Landslides –Tsunami Fire hazards **Earthquake Disaster -** Earthquake Hazard Map -Causes of Earthquakes -Classification of Earthquakes - -Seismic waves -Energy release - Inertia forces, Natural period -Resonance, Damping -Seismic response of free vibration -Seismic response of damped vibration -Performance of ground and buildings in past Earthquakes-Earthquake resistant measures in RC and Masonry buildings -Potential deficiencies of RC and Masonry buildings **Landslides –** Landslide zoning map **-** Causes –Protection measures **Floods –** Flood zone map **-** Effects on buildings – protection measures from damage to buildings – Mitigation Strategies

Tropical cyclones - Effects on buildings – protection measures from damage to buildings **Tsunami -** Tsunami magnitude and intensity -Tsunami wave characteristics -Peculiarities of tsunami deposits -Tsunami impact on coastal lines -Effects of Tsunami on built structures – Mitigation Management **Nuclear disaster** – chemical and industrial accidents - Mitigation strategies **Hazard Assessment -** Vulnerability Assessment and seismic strengthening of buildings -Vulnerability Assessment of Buildings procedure -Hazard Assessment-Visual Inspection and Study of Available Documents-Detailed In - situ Investigation Planning and Interpretation of Results-Foundation Capability -Non- structural Components -Seismic Strengthening of Buildings-Repairs Restoration Strengthening of Existing Buildings Strengthening Materials-Retrofitting of Load Bearing Wall Buildings Retrofitting of RC Buildings- **Alternative communication systems during disaster-** Modes of emergency communications-Satellite based communication systems -Radio communications **Role of local and state bodies**Natioanallevel,State level , district level -Community contingency plan –Risk Management - Vulnerabilty mapping.

Reference Books:

10. Ray.N.Glough, Joseph Penzein, (1996), “Dynamics of Structures”, McGraw Hill International Ltd.
11. Jaikrishna&A.R.Chandrasekaran, (1996) “Elements of Earthquake Engineering”,SaritaPrakashan, Meerut.
12. Berg.GV (1982), “Seismic Design codes and procedures”, EERI, CA.
13. Booth, Edmund (1994), “Concrete Structures in earthquake regions; Design and Analysis”, Longman.
14. Dowrick. D.J (1987), “Earthquake resistant design for Engineers and Architects”,John Wiley & Sons, Second Edition.
15. G.K. Ghosh(1993) “Disaster Management” A.P.H. Publishing Corporation,New Delhi
16. R.B. Singh (1992)“Disaster Management”RawatPublications,New Delhi
17. Ayaz Ahmad(1990) Disaster Management: Through the New Millennium By Anmol Publications,New Delhi
18. Goel, S. L.(1991) “Encyclopaedia of Disaster Management” Deep & Deep Publications PvtLtd,New Delhi

IS Codes:

3. IS: 4326-1984, “Indian Std Code of practice for Earthquake Resistant Design and Construction of Buildings”.
4. IS: 1893 (Part I)-2002 “Code of practice for Earthquake Resistant Design of Structures

Course Designers:

Dr.R.Ponnudurai rpdciv@tce.edu

14CEGDO	PROJECT MANAGEMENT	Category	L	T	P	Credit
		GE	2	2	0	3

Preamble

This course gives an exposure to the basic concepts involved in the formulation of a project, project management principles, importance and need for network techniques and its applications to a project.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to:		Expected Attainment Level (%)	Expected Proficiency Level(grade)
(CO1) **Explain project, project management, life cycle and project formulation**	**Understand**	**70**	**A**
(CO2) Analyze and Manage time in projects through Gantt charts, And network techniques.	**Apply**	**70**	**A**
(CO3) Analyse and manage time in projects through CPM and PERT, update and monitor projects	**Apply**	**70**	**A**
(CO4) Manage resources of project using resource smoothing and levelling techniques	**Analyze**	**70**	**A**
(CO5) Optimize resources of projects using scheduling, fast tracking and re-estimation techniques	**Apply**	**70**	**A**
(CO6) **Identify the need for communication and risk management in projects with emerging trends in project management**	**Apply**	**70**	**A**

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO45.	L	L	L	L	-	M	L	L	M	M	L	M
CO46.	S	M	M	M	M	-	-	L	M	L	S	M
CO3	S	M	M	M	M	-	-	L	M	L	S	M
CO4	S	M	M	M	-	M	L	-	L	M	-	S
CO5	S	M	M	S	-	M	L	-	L	M	-	S
CO6	L	L	L	L	L	-	M	-	S	M	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	10	10	10
Understand	20	10	10	10
Apply	60	60	60	60
Analyze	0	20	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

110. **Define project and project management. Mention its need**
111. **Discuss the functions of project management**
112. **Discuss the life cycle of projects with influencing factors**

Course Outcome 2 (CO2):

113. **Differentiate between CPM and PERT**
114. **A project consists of six activities with the following logical relationships. Draw a network for the project and determine the critical path using traditional method**

- A and B are initial activities and can be performed concurrently
- C follows A but cannot start until B is over
- D and E succeed B
- C and D precede F
- E and F are terminal activities

Activity	A	B	C	D	E	F
Duration (Days)	7	8	3	2	7	4

Find the status of the project on the 10th day of its commencement.

115. **Conduct Event oriented network analysis for the following project and determine:**

- Earliest and latest allowable occurrence times for the events
- Expected time and standard deviations for activities

- Project completion time and its degree of variability
- What is the probability of completing the project 2 days ahead of schedule?
- What is the probability of not completing the project 1 day behind schedule?
- Find the due date that has 75% chance of being met?

Activity (i-j)	1-2	1-3	2-4	3-4	3-5	4-5	5-6
t_0 days	2	3	4	0	7	2	4
t_m days	3	3	10	0	12	7	6
$t_p$days	5	3	12	0	15	9	8

Course Outcome 3 (CO3)

116. **Write the need for balancing of resources in project? Mention its significance**
117. **For an automobile industry project you as a project manager is vested with the responsibility of balancing manpower requirement, which method would you adopt for this process. Justify your answer with suitable reasons.**
118. **Balance the resource demand for the following project so as to meet the availability of only 7 men/day**

Activity (i-j)	0-1	0-3	0-6	1-2	3-4	3-7	6-7	2-5	4-5	7-8	5-8
Duration (days)	2	2	1	4	5	8	3	1	4	5	3
Manpower	3	6	4	2	2	4	5	4	2	2	5

Course Outcome 4 (CO4)

1. Define the term direct cost in projects with examples
2. Write the need and meaning of fast tracking and estimation of projects
3. A project consists of 7 activities with costs and times gives as shown in table. Crash the project and determine the optimum time and minimum cost relationship for the project. Assume the indirect cost to vary at Rs.500/- per day.

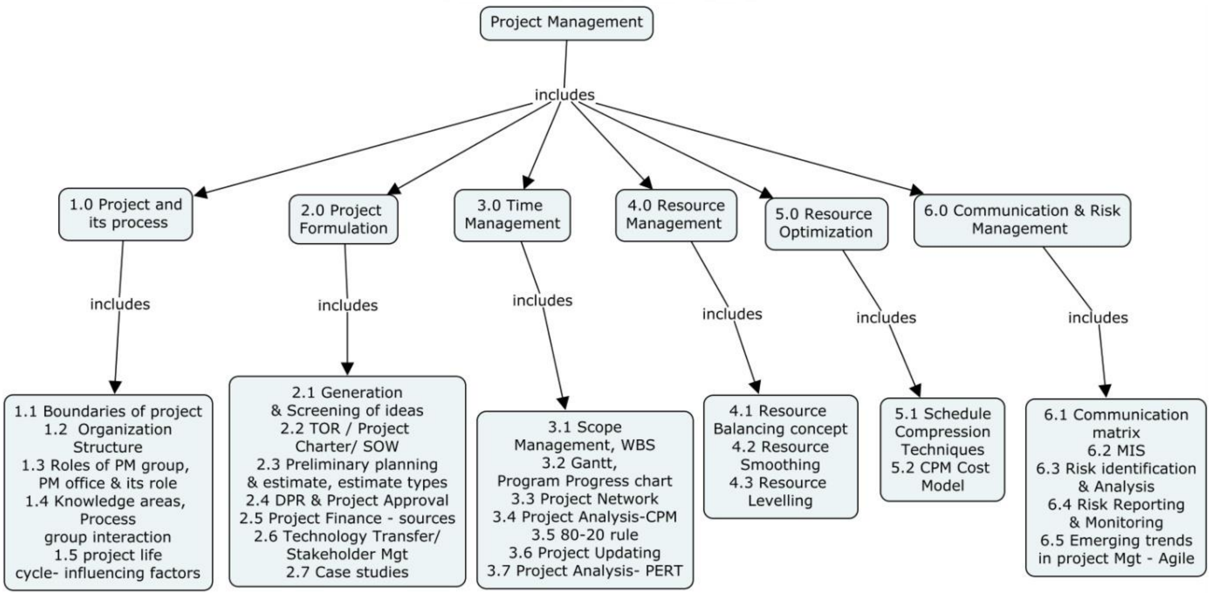
Activity (i-j)	1-2	1-3	2-4	3-4	3-5	4-5	5-6
Normal time days	5	7	4	2	5	3	4
Crash time days	3	4	2	1	3	2	1
Normal cost Rs.	500	100	200	400	350	380	50

Crash cost Rs.	800	300	500	750	800	900	150

Course Outcome 5(CO5)

4. List the benefits and limitations of latest tools in project management
5. **Discuss why effective communication is needed for the success of any projects taking an example**
6. **Take of project of your choice in a mechanical industry and list and discuss the risks in the project along with possible methods of its mitigation.**

Concept Map



Syllabus

Project and its process- Define project and process, boundaries of project, Objectives and functions of Project management, characteristics and types of projects, organization structure / styles, roles of project management group, project management office and its role, project knowledge area, project integration- process group interaction. Project flow, project life cycle- influencing factors. - Case study. **Project Formulation:** Generation and Screening of PM ideas- Triple Constraint – Time, Cost and Scope. TOR/ Project Charter/ SOW (Statement of Work)- Creation of project Charter. Preliminary planning and estimate- Types of estimate- Ball park, Parametric and Bottom up estimates. Project Presentation & Approval – Detailed Project Report & Approval (Technical and Budget Sanction), Project finance- sources of finance. Technology transfer- PPP Concepts,BOT, BOLT, BOOT. Stakeholder Management - Case study. **Time Management:** Project Scope Management - Work break down structure- Activity/ Task- Events- Case study. Project planning tools- Rolling wave planning. Gantt Charts, Milestone chart, Program Progress chart- Creating milestone plan. Project Network- Fulkerson's rules – Activity-On-Arrow and Activity- On -Node networks. Analyze project time- Critical path method (deterministic approach- activity oriented network analysis- 80-20 rule- Case study, type of time estimates & Square network diagram. Project updating and monitoring- Case study. Estimate time- Program Evaluation & Review Technique (Probabilistic Approach)- Event oriented network analysis- Optimistic, Pessimistic and Most likely time, Degree of variability in average time, Probabilistic estimate, % utilization of resources. **Resource Management:** Types of resource- Time, Men, Material, Machinery, Money, Space. Balancing of resource- Resource Smoothing technique- Time constraint. Resource levelling technique- Resource constraint- Case study. **Resource optimization:** Types of cost – Direct, Indirect and Total Cost. Variation of Cost with time. Schedule Compression Techniques- Crashing, Fast Tracking & Re-estimation- Crash time and crash cost. Optimize project cost for time and resource.CPM Cost model. **Communication Management:** Communication Management- meaning and process, communication matrix, Management information system, Guidelines of meeting- Case study. **Risk Management:** Risk management – meaning and process, Risk identification and analysis techniques- FMEA and SWOT analysis- Risk reporting and monitoring- Case study. **Emerging trends in project Management:** Introduction to Theory of Constraints, Agile Project management - Case study. Stakeholder Management – brief idea.

Text Book

3. Punmia B. C. and Khandelwal K.K., "Project Planning and Control with PERT/CPM", Laxmi publications, New Delhi, 1989.
4. "A Guide to the Project Management Body of Knowledge (PMBOK Guide) - Fifth Edition, An American National Standard, ANSI/PMI 990001-2008"

References

6. Jerome D. Wiest and Ferdinand K. Levy, "A Management Guide to PERT/CPM", Prentice Hall of India Publishers Ltd., New Delhi, 1994.
7. Srinath L.S., "PERT & CPM- Principles and Applications", Affiliated East West Press Pvt., Ltd., New Delhi, 2008
8. A Risk Management Standard, AIRMIC Publishers, ALARM, IRM: 2002
9. Gene Dixon, "Service Learning and Integrated Collaborative Project Management", Project Management Journal, DOI:10.1002/pmi, February 2011, pp.42-58
10. *NPTEL videos at nptel.ac.in/courses/112102106 by Prof. Arun Kanda, Dept of Mechanical Engineering, IIT, Delhi*

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.0	**Project and its process**	
1.1	Define project and process, boundaries of project	1
1.2	Objectives and functions of Project management, characteristics of projects, Organization structure / styles of project	1
1.3	Roles of project management group, project management office and its role	1
1.4	Project knowledge area, project integration- process group interaction	1
1.5	Project flow, project life cycle- influencing factors, Case study	1
2.0	**Project Formulation**	
2.1	Generation and Screening of PM ideas, Triple Constraint – Time, Cost and Scope	1
2.2	TOR/ Project Charter/ SOW (Statement of Work)- Creation of project Charter	2
2.3	Preliminary planning and estimate- Types of estimate- Ball park, Parametric and Bottom up estimates	1
2.4	Project Presentation and Approval- Detailed Project Report and Approval (Technical and Budget Sanction)	1
2.5	Project Finance - sources	1
2.6	Technology Transfer – PPP (BOT,BOLT, BOOT), Stakeholder Management	2
2.7	Case study - Tutorial	2
3.0	**Time Management**	
3.1	Project Scope Management, Work break down structure -Activity/ Task-Events- Case study. Project planning tools- Rolling wave planning	2
3.2	Gantt Charts, Milestone chart, Program Progress chart- Creating milestone plan	2
3.3	Project Network- Fulkerson's rules – A-O-A and A-O-N networks Introduction to project management software	2
3.4	Analyze project time- Critical path method (deterministic approach- activity oriented network analysis- Square network diagram	2
3.5	80-20 rule, type of time estimates - Case study	1

3.6	Project updating and monitoring- Case study	1
3.7	Estimate time- Program Evaluation & Review Technique (Probabilistic Approach)- Event oriented network analysis- Optimistic, Pessimistic and Most likely time, Degree of variability in average time, Probabilistic estimate, % utilization of resources.	2
	Tutorial	2
4.0	**Resource Management**	
4.1	Types of resource- Time, Men, Material, Machinery, Money, Space. Balancing of resource- need and purpose- Case study	1
4.2	Resource Smoothing technique- Time constraint	2
4.3	Resource levelling technique- Resource constraint	2
	Tutorial	2
5.0	**Resource optimization**	
5.1	Types of cost – Direct, Indirect and Total Cost. Variation of Cost with time. Schedule Compression Techniques- Crashing, Fast Tracking & Re-estimation Crash time and crash cost	2
5.2	Optimize project cost for time and resource- CPM Cost model- Case study	2
	Tutorials	2
6.0	**Communication & Risk Management**	
6.1	Communication Management- meaning and process, communication matrix	1
6.2	Management information system, Guidelines of meeting- Case study	1
6.3	Risk management – meaning and process. Risk identification and analysis techniques- FMEA and SWOT analysis	1
6.4	Risk reporting and monitoring- Case study	1
6.5	Emerging trends in project management: (Brief concept only)- Theory of Constraints, Agile Project Management. Stakeholder management – brief concept	1
	Total Periods	**48**

Course Designers:

1. Dr. G. Chitra gcciv@tce.edu
2. Dr. S. Chandran schandran@tce.edu

Category	L	T	P	Credit
GE	3	0	0	3

14CEGE0 **ROAD SAFETY**

Preamble

The course has an exposure to the basic principles of road safety, traffic rules and regulations. It provides broad ideas and suggestions for safety of vulnerable road users.

Prerequisite

Nil

Course Outcomes

	At the end of the course, the students will be able to:		Expected Attainment **Level (%)**	Expected Proficiency **Level (grade)**
CO1	Enumerate the concepts of road safety and its principles	Understand	70	A
CO2	Enumerate the need for crash data and analysis	Understand	70	A
CO3	Apply the knowledge of traffic flow concepts at intersections	Apply	70	A
CO4	Apply the knowledge of road markings, traffic signs and signals for safe driving	Understand	70	A
CO5	Enumerate the traffic policies and regulations for vulnerable road users	Understand	70	A
CO6	Enumerate the road safety management techniques	Understand	70	A

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO47.	L	-	-	M	-	-	-	-	-	-	-	-
CO48.	L	-	-	M	-	-	M	-	-	-	-	-
CO3	M	-	L	S	-	-	M	L	-	-	-	-
CO4	M	-	L	S	-	-	-	L	-	-	-	-
CO5	L	-	-	M	-	-	-	-	-	-	-	-
CO6	L	-	-	M	-	-	-	-	-	-	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

S. No.	Blooms Category	Test-1	Test-2	End semester Examination
1.	Remember	20	20	20
2.	Understand	50	50	50
3.	Apply	30	30	30
4.	Analyze	0	0	0
5.	Evaluate	0	0	0
6.	Create	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. Define the term road safety based on science perspectives.
2. List various road demographics for understanding road safety.
3. Mention the various uses of crash data.
4. Draw a sketch of pedestrian crossing.
5. State the need for international standardization for traffic signs and signals.

Course Outcome 2 (CO2)

1. Draw the sketch of half cloverleaf and shown the traffic flow directions.
2. List out the important sections of Motor Vehicle Act related to road safety.
3. List the regulatory measures for pedestrians.
4. Mentions few road safety management techniques adopted in the urban locations.
5. List the countermeasures to be taken to avoid accidents during driving.
6. Mention the traffic rules to be followed while driving in rural areas.

Course Outcome 3 (CO3)

1. Discuss traffic management measures and their influence in the accident prevention in metro cities.
2. Discuss the details required for preparation of collision diagram and crash data analysis.
3. Draw a neat sketch of a four lane carriageway and discuss the lane markings, obstruction approach marking, STOP lines and route markings.

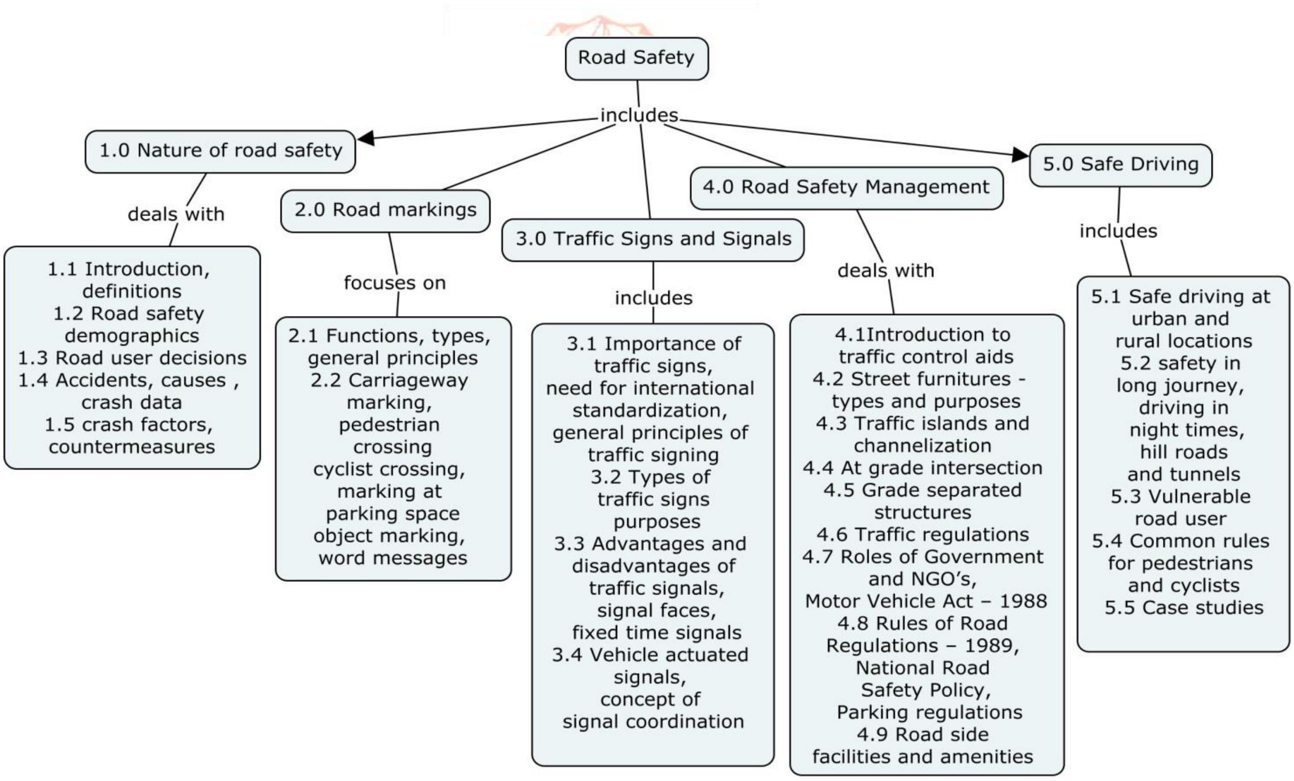
Course Outcome 4 (CO4)

1. Discuss the various causes of accidents.
2. Discuss the need for study on crash data.
3. Write the objectives of road safety management.
4. Discuss the role of Government and NGO's in road safety management.
5. Discuss the merits and limitations of providing grade separated structures.

Course Outcome 5 (CO5)

1. Compare the various types grade separated structures.
2. Discuss various types of signs used for road users.
3. Write the need for road safety management programs.
4. Write the significance of Motor vehicle Act in road safety in Indian Scenario.
5. Discuss the regulation given by Indian Government for vulnerable road users.
6. Discuss the essential road side facilities provided for road users.

Concept Map



Course Contents and Lecture Schedule

S. No.	Topics	Periods
1.0	**Nature of road safety**	
1.1	Introduction, definition - science based perspectives	1
1.2	Road safety demographics	2
1.3	Road user decisions	1
1.4	Classification of accidents, causes Origin, characteristics and uses	2

	of crash data	
1.5	Contributing to crash factors, countermeasures	2
2.0	**Road markings**	
2.1	Functions, types, general principles	1
2.2	Carriageway marking, pedestrian crossing, cyclist crossing, marking at parking space, object marking, word messages	3
3.0	**Traffic Signs and Signals**	
3.1	Importance of traffic signs, need for international standardization, general principles of traffic signing	2
3.2	Types of traffic signs – purposes	1
3.3	Advantages and disadvantages of traffic signals, signal faces, fixed time signals	1
3.4	Vehicle actuated signals, concept of signal coordination	1
4.0	**Road Safety Management**	
4.1	Introduction to traffic control aids	1
4.2	Street furnitures - types and purposes	1
4.3	Traffic islands and channelization – general principle and purposes, street lighting	3
4.4	At grade intersection – types, conflict points	1
4.5	Grade separated structures – types, advantages and disadvantages, traffic flow concepts	1
4.6	Traffic regulations – basic principles, Roles of Government and NGO's, Motor Vehicle Act – 1988	2
4.7	Rules of Road Regulations – 1989, National Road Safety Policy, Parking regulations	1
4.8	Road side facilities and amenities – general principles and purposes	1
5.0	**Safe Driving**	
5.1	Tips and suggestions for safe driving at urban and rural locations	1
5.2	safety in long journey, driving in night times, hill roads and tunnels	2
5.3	vulnerable road user – regulatory measures for motor cycle and scooter riders	2
5.4	Common rules for pedestrians and cyclists.	1

5.5	Case studies	2
	Total Periods	**36**

Syllabus

Nature of road safety – science based perspectives, road safety demographics, and road user decisions. Classification of accidents, blackspots, causes - roadside hazards, Origin, characteristics and uses of crash data – contributing to crash factors, countermeasures. **Road markings** – functions, types, general principles, carriageway marking, pedestrian crossing, cyclist crossing, marking at parking space, object marking, word messages. **Traffic signs and signals** – importance of traffic signs, need for international standardization, general principles of traffic signing, types of traffic signs – purposes. Traffic signals - Advantages and disadvantages, signal faces, fixed time signals, vehicle actuated signals, concept of signal coordination. **Road safety management –** traffic control aids – street furnitures, traffic islands and channelization, street lighting, at grade intersection – types, conflict points, grade separated structures – types, advantages and disadvantages, traffic flow concepts. Traffic regulations – basic principles, Roles of Government and NGO's, Motor Vehicle Act – 1988, Rules of Road Regulations – 1989, National Road Safety Policy, Parking regulations. Road side facilities and amenities – general principles and purposes. **Safe Driving** – Tips and suggestions for safe driving at urban and rural locations, safety in long journey, driving in night times, hill roads and tunnels, vulnerable road user – regulatory measures for motor cycle and scooter riders, common rules for pedestrians and cyclists.

Text Books

1. **Kadiyali L.R,** "Traffic Engineering and Transport Planning", Khanna Publishers, New Delhi, seventh edition, 2011.

References

11. Elvik Rune, "The Handbook of Road Safety Measures", Emrald Group Publishing Limited, 2nd revised edition 2009
12. Ashwini Bagga and Nisha Bagga, "Essentials of Road Safety", Mayas Publishers, 2012
13. Highway Safety Code, Indian Road Congress, New Delhi, 1996
14. Transportation Planning Handbook, The Institute of Transportation Engineers, Prentice Hall, Englewood Clifts, 1992
15. Code of Practice for Road Markings, IRC: 35 – 1970, revised edition, 1990
16. Recommended Practice for Road Delineators, IRC:79 Indian Road Congress, New Delhi, 1981
17. The Diver's Handbook, Government of South Australia, published in 2015
18. www.indiatransportportal.com, 2012
19. www.morth.nic.in
20. www.legislation.sa.gov.au

Course Designers:

1. D.Srividya dsciv@tce.edu
2. Dr. R.Velkennedy rvkciv@tce.edu

14CEGF0 BASICS OF CLIMATE SCIENCE AND POLICY

Category	L	T	P	Credit
GE	3	0	0	3

Preamble

Science has established the existence of climate change and related anthropogenic activity as the leading cause of it. There is a need to understand climate science, the implications on various regions, resources, societies, and to study ways of mitigating its impacts. Role of policies and measures are also equally important. The aims of this course are to provide basic understanding about the climate system: its attributes, underlying processes, and the drivers of climate change. This course will provide basic understanding about important climate variables, which are indicators and predictors of the changes in the climatic systems.

Prerequisite

Nil

Course Outcomes

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

			Expected Attainment Level (%)	Expected P Proficiency Level (grade)
CO1	Explain the workings of the climate systems and feedback mechanisms.	Understand	80	B
CO2	Apply climate science related knowledge to solve societal problems	Apply	80	B
CO3	Assess the Climate related Issues in different engineering Disciplines.	Apply	80	B
CO4	Choose relevant options (technological and policy) for mitigating climate change	Apply	80	B

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO49	S	M	-	-	-	-	-	S	-	M	-	-
CO50	S	S	S	M	-	M	L	-	S	L	L	-
CO3	S	S	S	M	-	-	M	L	L	L	M	L
CO4	S	M	-	S	-	S	S	L	L	L	S	L

S- Strong; M-Medium; L-Low

Assessment Pattern

S.No	Blooms Category	Test – 1	Test – 2	Test – 3 / End semester examination
1	Remember	20	20	20
2	Understand	50	50	50
3	Apply	30	30	30
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. With a help of case studies discuss why climate change is irreversible
2. Summarize your views on climate change and explore the answers for unanswered questions behind it.
3. Critically analyze the roles and responsibilities of various agencies towards fighting Global Warming and Climate change.
4. How climate change affects human health in dry and arid region?
5. The consumption of fuel in India is increasing everyday and cost of it too. Propose a suitable alternate fuel for the future after analyzing the pros and cons of its implementation.

Course Outcome 2 (CO2):

1. List the Green House gases.
2. Draw the atmospheric profile of temperature
3. Define carbon foot print.
4. Define the term low carbon economy
5. What is Kyoto protocol

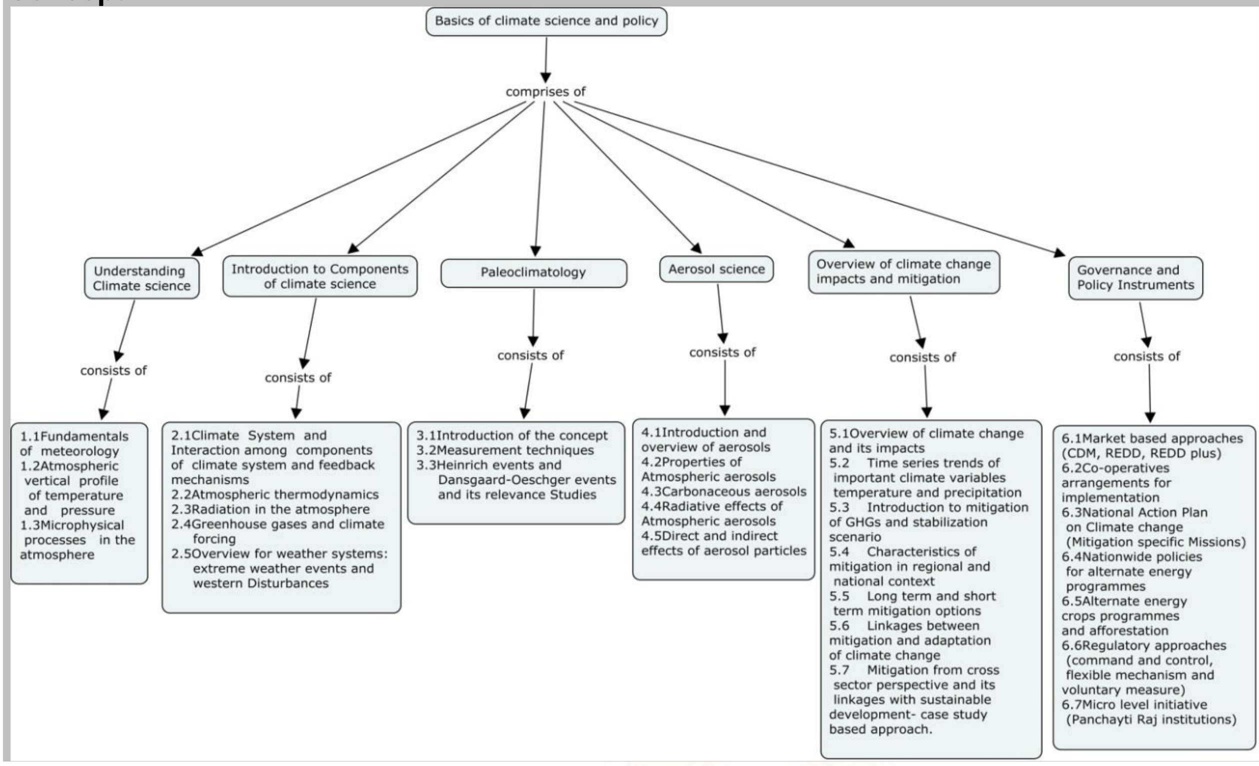
Course Outcome 3 (CO3):

1. Write funding status of Indian Government on climate change mitigation and adaptation.
2. Review the India's policy initiatives towards climate change
3. Discuss in detail about climate sensitivity and its feedback.
4. Discuss the classification of climate.

Course Outcome 3 (CO3):

1. Explain the Global warming phenomenon and its effect.
2. Discuss the uncertainties in the projected impact of climate change.
3. Discuss the relation between global ocean circulation and climate change.
4. Discuss the factor to be considered for the preparation of flood inundation plant for your city.

Concept Map



Syllabus

Understanding climate science: Fundamentals of meteorology, atmospheric vertical profile of temperature and pressure, microphysical processes in the atmosphere. **Introduction to components of climate science:** Climate System and Interaction among components of climate system and feedback mechanisms, Atmospheric thermodynamics, radiation in the atmosphere, greenhouse gases and climate forcing. overview for weather systems: extreme weather events and western disturbances. **Paleoclimatology:** Introduction of the concept, measurement techniques, Heinrich events and Dansgaard-Oeschger events and its relevance studies. **Aerosol science:** Introduction and overview of aerosols, properties of atmospheric aerosols; carbonaceous aerosols; radiative effects of Atmospheric aerosols; direct and indirect effects of aerosol particles.**Overview of climate change impacts and mitigation:** Overview of climate change and its impacts; time series trends of important climate variables temperature and precipitation, Introduction to mitigation of GHGs and stabilization scenario; characteristics of mitigation in regional and national context; long term and short term mitigation options; Linkages between mitigation and adaptation of climate change. Mitigation from cross sector perspective and its linkages with sustainable development- case study based approach. **Governance and Policy Instruments:** market based approaches (CDM, REDD, REDD plus); Co-operatives arrangements for implementation; National Action Plan on Climate change (Mitigation specific Missions); Nationwide policies for alternate energy programmes; alternate energy crops programmes and afforestation; Regulatory approaches (command and control, flexible mechanism and voluntary measure), Micro level initiative (Panchayat Raj institutions)

Text Book

1. Banerjee K.K.(2005) Global Warming Database Technology Options in Power and End-use Sectors Using Fossil Fuels, New Delhi.
2. Gupta M.(2006) Restricting Greenhouse Gas Emissions: Economic Implications for India, New Delhi.

Reference Books

1. Barbara J., Pitts F. and Pitts J.N.,Jr (2000) Chemistry of the Upper and Lower Atmosphere-Theory, Experiments and Applications Academic Press, San Diego.
2. Climate Change Science: An Analysis of Some Key Questions-National Academy of Sciences Committee on the Science of Climate Change, (National Academy Press, Washington, DC, 2001.
3. Marshall J. and Plumb R.A. (2001) Atmosphere, Ocean and Climate, *Elsevier*, Amsterdam.
4. Oliver J.E. and Hidore J.J. (2008) *Climatology: An Atmospheric Science*, Prentice Hall.
5. Seinfeld J.H. and Pandis S.N. (2006) Atmospheric Chemistry and Physics-from Air Pollution to Climate Change, John Wiley and Sons, INC.
6. Hardy J.(2003) Climate Change: Causes, Effects and Solutions, John Wily & Sons.
7. Nakicenovic N. (Eds) (1993) Integrative Assessment of Mitigation, Impacts and Adaptation to Climate Change, Austria.
8. Sathaye J. and Meyers S.D.(1995) Greenhouse Gas Mitigation Assessment: A Guidebook, Kluwer.
9. Thomas S.(2003) Policy Instruments for Environment and Natural Resource Management, RFF Publication, Washington DC.
10. Tiwari G.N.(2003) Greenhouse Technology for Controlled Environment, New Delhi.

Course content and Lecture schedule

Module No	Topics	No. of Lectures
1.0	**Understanding Climate science**	
1.1	Fundamentals of meteorology	1
1.2	Atmospheric vertical profile of temperature and pressure	2
1.3	Microphysical processes in the atmosphere	1
2.0	**Introduction to Components of climate science**	
2.1	Climate System and Interaction among components of climate system and feedback mechanisms	1
2.2	Atmospheric thermodynamics	1
2.3	Radiation in the atmosphere	1
2.4	Greenhouse gases and climate forcing	2
2.5	Overview for weather systems: extreme weather events and western Disturbances	1
3.0	**Paleoclimatology**	
3.1	Introduction of the concept	1

3.2	Measurement techniques	1
3.3	Heinrich events and Dansgaard-Oeschger events and its relevance Studies	2
4.0	**Aerosol science**	
4.1	Introduction and overview of aerosols	1
4.2	Properties of Atmospheric aerosols	1
4.3	Carbonaceous aerosols	1
4.4	Radiative effects of Atmospheric aerosols	1
4.5	Direct and indirect effects of aerosol particles	2
5.0	**Overview of climate change impacts and mitigation**	
5.1	Overview of climate change and its impacts	1
5.2	Time series trends of important climate variables temperature and precipitation	1
5.3	Introduction to mitigation of GHGs and stabilization scenario	1
5.4	Characteristics of mitigation in regional and national context	2
5.5	Long term and short term mitigation options	1
5.6	Linkages between mitigation and adaptation of climate change	1
5.7	Mitigation from cross sector perspective and its linkages with sustainable development- case study based approach.	2
6.0	**Governance and Policy Instruments**	
6.1	Market based approaches (CDM, REDD, REDD plus)	1
6.2	Co-operatives arrangements for implementation	1
6.3	National Action Plan on Climate change (Mitigation specific Missions)	1
6.4	Nationwide policies for alternate energy programmes	1
6.5	Alternate energy crops programmes and afforestation	1
6.6	Regulatory approaches (command and control, flexible mechanism and voluntary measure)	1
6.7	Micro level initiative (Panchayati Raj institutions)	1
	TOTAL	**36**

Course Designers

1. Mr. V. RaviSankar environmentengr@tce.edu
2. Dr. S. Chandran schandran@tce.edu

14CE1A0	PRACTICAL VALUATION	Category	L	T	P	Credit
			1	0	0	1

Preamble

This course addresses the overall idea of Practical Valuation of land and buildings.

Prerequisite

Nil

Course Outcomes

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

	On the successful completion of the course, students will be able to		Expected Attainment level (%)	Expected Proficiency level (grade)
CO1	Identify the factors influencing valuation of a property	Understand	80	S
CO2	Apply the principles of valuation for Valuation of open land, Building, plant and Machinery.	Apply	80	S
CO3	Calculate the value of a property through various methods of valuation and prepare reports based on international financial reporting system	Apply	**80**	**S**

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2
CO51.	M	-	-	-	-	L	-	-	-	-	-	-	L	-
CO52.	S	-	-	-	-	L	-	-	-	-	-	-	L	-
CO3	S	-	-	-	-	L	-	-	-	-	-	L	L	-

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Test	Terminal Examination
	1	
Remember	**20**	**20**
Understand	**40**	**40**
Apply	**40**	**40**
Analyse	**-**	**-**

Evaluate	-	-
Create	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. Define Cost, Price, and Value and Explain different kinds of properties
2. What are the different methods of valuation?
3. Define Plinth area, floor area, Carpet area? Whether super built up area is recognized by BIS
4. Indicate any five different purpose of Valuation

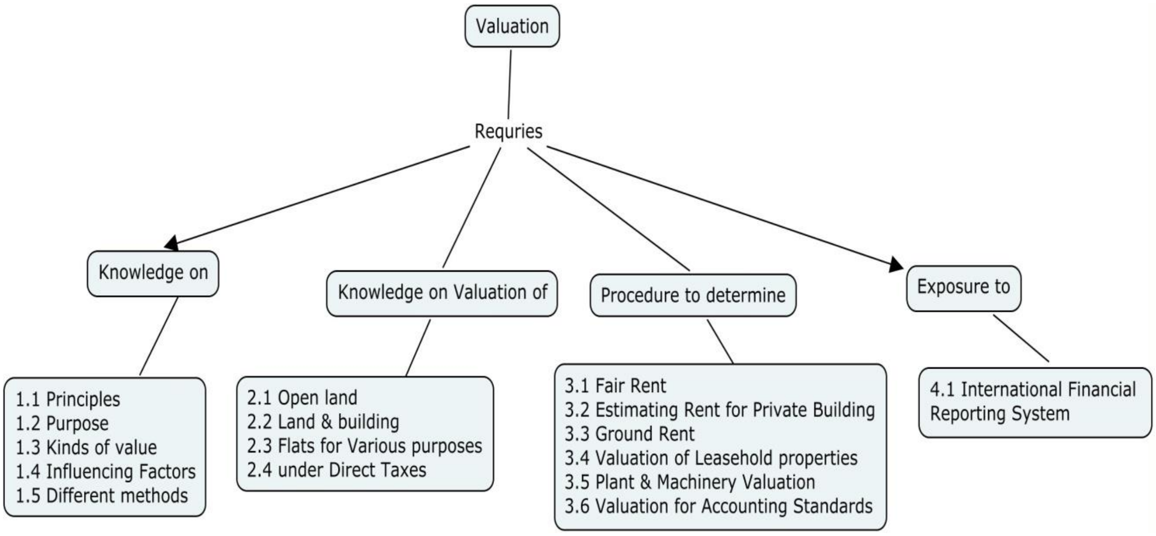
Course Outcome 2 (CO2)

1. What are the factors affecting value in General?
2. What are the two Principal interests in a property
3. Explain FSI, Floor area Ratio, Plot Coverage, Set Backs
4. Describe various types of Value.
5. Explain in detail about hypothetical value alongwith examples and comment on whether hypothetical value can be adopted in valuation

Course Outcome 3 (CO3)

1. For a plot of 300 sq. m area, estimate the approximate cost of construction of the building meant for I.T.Purpose situated in the outskirts of city limit
2. For a residential building on the first floor of a 2-storey building in a Madurai Palanganatham area with 15 years of construction, fix the rent as per Tamil Nadu Rent Contract Act. Justify your suggestions.
3. What are all the aspects to be considered in report writing for the purpose of Valuation for Banks?
4. Explain about salient features of IFRS and its relevance to Valuation of properties.

Concept Map



Syllabus

Principles of Valuation, Purpose of Valuation, Kinds of Value, Factors affecting Value of property, Different methods of Valuation, Valuation of open land, Land & Building, Valuation of Flats for Various purposes, Valuation under Direct Taxes, Procedure to determine Fair Rent, Procedure of Estimating Rent for Private Building, Ground Rent, Valuation of Leasehold properties, Plant & Machinery Valuation, Valuation for Accounting Standards, International Financial Reporting System

Reference Books

1. Kanagasabapathy. B, “Practical Valuation” Vol I to VIII, M/s. Ezhilarasi Kanaga Sabapathy, Tiruchirappalai
2. Syamales Datta, “ Valuation of Real Property”, Eastern Law House Private Ltd, Calcutta, 2004
3. Roshan H.Namavati, “Theory & Practice of Valuation”, Lakhani Book Depot, Mumbai, 2010
4. Gopinatha Rao. C.H., “Valuation practice of Immovable properties” 2005
5. Banerjee D.N., “Principles & Practice of Valuation” 5th Edition, Eastern Law House Private Ltd, Calcutta,1998
6. Gupta P.C., “Valuation of Plant and Machinery”
7. L.Balaji, Course material on Practical Valuation

Course Contents and Lecture Schedule

S.No.	Topic	No. of Lectures
1.	Principles of Valuation	1
2.	Purpose of Valuation	1

3	Kinds of Value	1
4	Factors affecting Value of property	1
5.	Different methods of Valuation	1
6.	Valuation of open land, Land & Building	1
7.	Valuation of Flats for Various purposes	1
8.	Valuation under Direct Taxes	1
9.	Procedure to determine Fair Rent	1
10.	Procedure of Estimating Rent for Private Building, Ground Rent	1
11.	Valuation of Leasehold properties	1
12.	Plant & Machinery Valuation	1
13.	Valuation for Accounting Standards	1
14.	International Financial Reporting System	1
	TOTAL	**14**

Course designers

Er. L. Balaji, valuerbalaji@yahoo.co.in

			Category	L	T	P	Credit
14CE1B0	**ARBITRATION AND DISPUTE RESOLUTION**		PE	1	0	0	1

Preamble

This course will create awareness on contracts for construction industry, laws on arbitration, arbitration procedure and laws on dispute resolution in India.

Course Outcomes

	At the end of the course the graduates will be able to:		**Expected Attainment level (%)**	**Expected Proficiency level (grade)**
C01.	Enumerate the laws on contracts for construction industry in India, procedure for arbitration and dispute resolution	Understand	80	S
CO2.	Apply appropriate methods to assess the critical factors in contracts leading to arbitration and disputes between the parties	Apply	80	S
CO3.	Suggest suitable type of arbitration or dispute resolution for the situation of problem	Apply	80	S

Mapping with Programme Outcomes

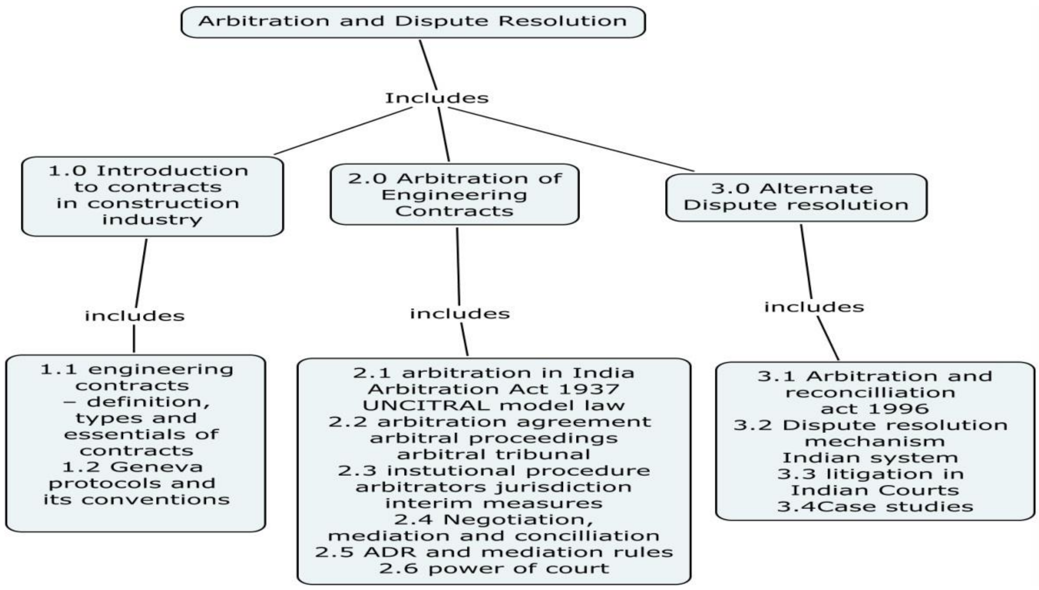
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2
CO1.	M	M	M	M	L	-	-	-	-	-	M	-	L	-
CO2.	S	S	M	M	M	-	-	-	-	-	M	-	L	-
CO3.	S	S	M	M	M	-	-	-	-	-	M	-	L	-

S- Strong; M-Medium; L-Low

Assessment Pattern

S. No.	Bloom's Category	Test 1	Test 2	End -semester Examination
1.	Remember	30	30	30
2.	Understand	40	40	40
3.	Apply	30	30	30
4.	Analyze	0	0	0
5.	Evaluation	0	0	0
6.	Create	0	0	0

Concept Map



Course Level Learning Objectives

Course Outcome 1 (CO1):

1. Mention various types of contracts
2. Write the essentials of contract
3. Discuss the essentials and clauses of contract.
4. Discuss the Geneva Protocols and its conventions.
5. Explain in detail UNCITRAL model law and its application

Course Outcome 2 (CO2):

1. Differentiate between Negotiation, mediation and reconciliation.
2. Explain the dispute resolution mechanism in Indian system.
3. There is a dispute between the contractor and the funding organization of a project on interpretation of quantum of work for payment of wages to the contractor. As an arbitrator for this case, discuss the procedure and powers you would exercise to settle the dispute in an unbiased manner.

Course Outcome 3 (CO3):

1. Explain the litigation in the Indian courts on disputes.
2. A highway is under distress which requires repair. The repair is to be let out as contracting work by calling for tenders. Identify a suitable type of contract that can be undertaken for the repair work with suitable reasons.

Course Content and Lecture Schedule

Module No.	Topics	No. of Lectures
1.0	**Introduction to contracts in construction industry**	
1.1	Brief details of engineering contracts – definition, types and essentials of contracts, clauses of contract	1
1.2	Brief details of Geneva protocols and its conventions.	1
2.0	**Arbitration of Engineering Contracts**	
2.1	Background of Arbitration in India, Indian Arbitration Act 1996, UNCITRAL model law	1
2.2	**Forms of arbitration** – arbitration agreement, Commencement of arbitral proceedings, Constitution of arbitral tribunal	1
2.3	Institutional procedure of arbitration, Impartiality and independence of arbitrator's jurisdiction of arbitral tribunal, Interim measures, Enforcement of awards.	2
2.4	Negotiation, Mediation and conciliation – concepts and purpose	1
2.5	Statutory back ground ADR and mediation rules	1
2.6	Duty of mediator and disclose facts, Power of Court in mediation.	1
3.0	**Alternate Dispute resolution**	
3.1	Structure of Indian Judicial, The arbitration and reconciliation ordinance 1996	1
3.2	The dispute resolution mechanism under the Indian judicial System	1
3.3	Litigation in Indian courts	1
3.4	case studies	2
	Total Periods	**14**

Syllabus

Introduction to contracts in construction industry: Brief details of engineering contracts – definition, types and essentials of contracts, – brief details of Geneva protocols and its conventions. **Arbitration of Engineering Contracts** – Background of Arbitration in India, Indian Arbitration Act 1937, UNCITRAL model law, **forms of arbitration** – arbitration agreement, Commencement of arbitral proceedings, Constitution of arbitral tribunal, Institutional procedure of arbitration, Impartiality and independence of arbitrators jurisdiction of arbitral tribunal, Interim measures, Enforcement of awards. Negotiation, Mediation and conciliation – concepts and purpose, statutory back ground ADR and mediation rules, Duty of mediator and disclose facts, Power of Court in mediation. **Alternate Dispute resolution** - Structure of Indian Judicial, The arbitration and reconciliation ordinance 1996, The dispute resolution mechanism under the Indian judicial System, Litigation in Indian courts, case studies.

References

1. B.J. Vasavada, "Engineering Contracts and Arbitration", Jubilee Publications, 1996
2. Roshan Namavati, "Professional Practice", Lakhani Book Depot, 2013

Course Designer:

Er. Sanna Ratnavel, Sceba Consultancy Services, Madurai, ratsiit@gmail.com

			Category	L	T	P	Credit
14CE1C0	**DURABILITY OF CONCRETE STRUCTURES**		PE	1	0	0	1

Preamble

Durable concrete will retain its original form, quality and serviceability when exposed to the environment. This course gives an exposure to the importance and need for making durable concrete with overview on factors affecting durability

Prerequisite

Fundamentals of Concrete Technology.

Course Outcomes

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

			Expected Attainment level (%)	Expected Proficiency level (grade)
CO1	Identify and describe the materials used in production of concrete along with concrete properties	Understand	80	S
CO2	Infer the need for making durable concrete and the factors affecting durability of concrete.	Understand	80	S
CO3	Predict the deterioration in concrete structures	Understand	**80**	**S**
CO4	Infer crack occurrence and crack measurement techniques	Understand	**80**	**S**

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1.	-	-	-	-	-	-	M	-	-	-	-	-	-	-
CO2.	M	M	M	L	-	-	-	-	-	-	L	-	L	-
CO3.	M	M	M	M	-	-	-	L	L	-	L	-	L	-
CO4.	L	M	L	-	-	M	S	L	-	L	L	-	L	-

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests	Terminal Examination
	1	
Remember	**20**	**20**
Understand	**80**	**80**
Apply	**---**	**---**
Analyse	**---**	**---**

Evaluate	**---**	**---**
Create	**---**	**---**

Course Level Assessment Questions

Course Outcome 1 (CO1)**:**

1. List the transport properties of concrete
2. Discuss the admixtures used in concrete
3. Can we control the coefficient of thermal expansion of concrete? If so, how?

Course Outcome 2 (CO2)**:**

1. What do you understand by the term durability?
2. Explain the factors governing the durability of concrete.
3. Defend the importance of durability considerations in the design and construction of concrete structures.

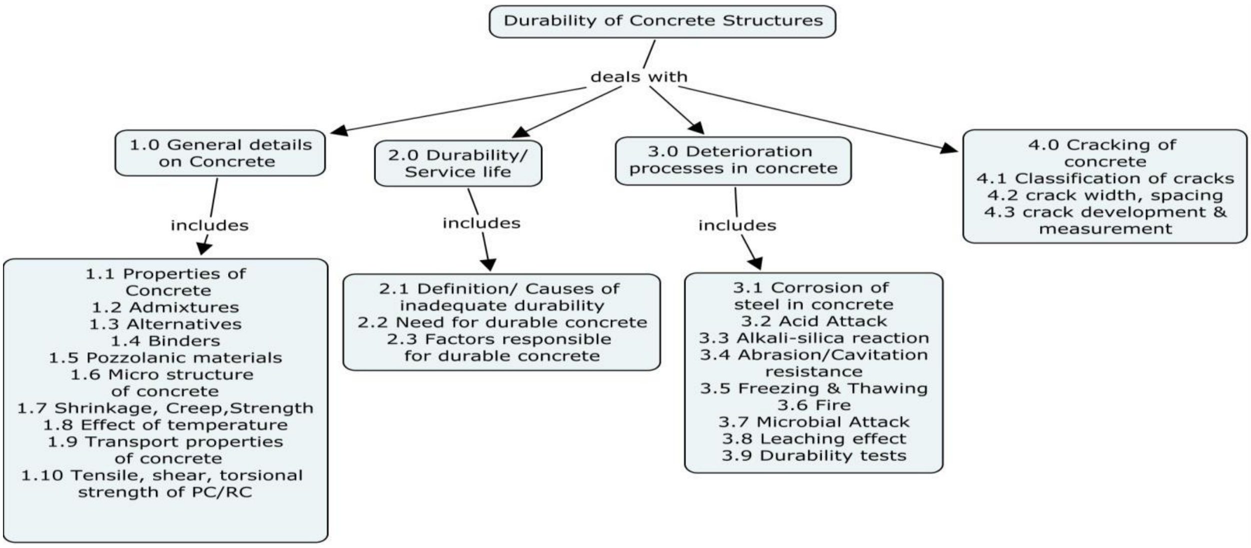
Course Outcome 3 (CO3)**:**

1. Outline the causes of corrosion of rebar in concrete
2. Briefly explain the causes and controlling of scaling and D-cracking in concrete
3. Explain alkali silica reaction

Course Outcome 4 (CO4)**:**

1. List the crack classification
2. Identify the sources of crack development in concrete
3. Explain the crack measurement techniques in detail.

Concept Map



Syllabus

Basic properties of concrete, special admixtures, alternatives, binders, pozzolanic materials and their reaction process in concrete, micro structure of concrete, shrinkage, creep and strength of concrete, effect of temperature on concrete, transport properties of concrete, tensile, shear bond and torsional strength of plain and reinforced concrete. Definition of durability and service life of concrete, causes of inadequate durability, need for durable concrete, factors responsible for durable concrete. Deterioration processes in concrete corrosion of steel in concrete, acid attack, alkali-silica attack, sulphate attack, alkali-carbonate reaction, efflorescence, scaling, erosion, alkali-silicate reaction, abrasion resistance, cavitations resistance, freezing-thawing resistance, fire resistance, microbial attack on concrete, leaching effects in concrete and testing for all these durability measures. Health monitoring of concrete structures - durability measuring devices.Methods of enhancing durability of concrete - re-alkalization of concrete and chloride removal from concrete. Cracking of concrete: Classification of cracks, crack width crack spacing, crack development and measuring techniques.

Reference Books

1. P. Kumar Mehta ,Paulo J. M. Monteiro, “Concrete: Microstructure, Properties, and Materials”, McGraw Hill Publication, 2014
2. A.M. Neville, “Properties of Concrete”, Pearson Publication, 2011

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	**General Details of concrete**	
1.1	Properties of Concrete	2
1.2	Special admixtures	
1.3	Alternatives	
1.4	Binders	
1.5	Pozzolanic materials and their reaction process in concrete	
1.6	Micro structure of concrete	
1.7	Shrinkage, creep and strength of concrete	1
1.8	Effect of temperature on concrete	
1.9	Transport Properties of concrete	
1.10	Tensile, shear bond and torsional strength of plain and reinforced concrete	
2.0	**Durability/ Service life**	
2.1	Definition of durability and service life of concrete, causes of inadequate durability	1
2.2	Need for durable concrete	
2.3	Factors responsible for durable concrete	
3.0	**Deterioration processes in concrete**	
3.1	Corrosion of steel in concrete	1
3.2	Acid attack and Sulphate attack	
3.3	Alkali-silica reaction	
3.4	Abrasion resistance, cavitations resistance	1
3.5	Freezing-thawing resistance	
3.6	Fire resistance	

3.7	Microbial attack on concrete	1
3.8	Leaching effects in concrete	
3.9	Various Tests on Durability	2
	Health monitoring of concrete structures – durability measuring devices	2
	Methods of enhancing durability of concrete - re-alkalization of concrete and chloride removal from concrete	1
4.0	**Cracking of concrete**	
4.1	Classification of cracks	1
4.2	Crack width crack spacing	
4.3	Crack development and measuring techniques	1
	TOTAL	**14**

Course Designers:

6. Dr. R. Selvarajselvarajcecri@gmail.com

14CE1D0	GREEN CONSTRUCTION	Category	L	T	P	Credit
		PE	1	0	0	1

Preamble

This course will create awareness on the impact of constructions on the environment and the various techniques of mitigating the adverse impacts

Prerequisite

Knowledge on building construction

Course Outcomes

	On the successful completion of the course, students will be able to:		Expected Attainment Level (%)	Expected Proficiency Level (grade)
CO1	Enumerate the aspects of green construction and certification systems	Understand	80	S
CO2	Select materials and appropriate construction technologies for the green construction	Apply	80	S
CO3	Plan green buildings knowing various innovative techniques	Apply	**80**	**S**
CO4	Apply concept of sustainability to various construction activities	Apply	**80**	**S**
CO5	Suggest Mitigation measures for environmental degradation	Apply	**80**	**S**
CO6	Address Impact of Life cycle effects, durability and certification process	Apply	**80**	**S**

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	M	-	-	-	-	-	-	-
CO2	M	M	M	L	-	-	-	-	-	-	L	-	L	-
CO3	M	M	M	M	-	-	-	L	L	-	L	-	L	L

CO4	L	M	L	-	-	M	S	L	-	L	L	-	L	L
CO5	-	L	M	M	-	M	S	-	-	L	L	-	-	L
CO6	L	-	-	-	-	-	-	-	-	-	M	L	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests	Terminal Examination
	1	
Remember	**10**	**10**
Understand	**50**	**40**
Apply	**40**	**50**
Analyze	**--**	**--**
Evaluate	**--**	**--**
Create	**--**	**--**

Course Level Assessment Question

Course Outcome 1 (CO1):

1. Write the meaning of green construction mentioning its need
2. Discuss the various aspects and measures taken to make a building green
3. Enumerate the salient features of green certification systems with purpose

1. List few materials used in green construction

Course Outcome 2 (CO2):

2. Relate sustainability with green construction with reasons
3. As a civil engineer having the knowledge on green construction, identify the material and technologies you would recommend for your buildings to attain sustainability. Discuss with suitable reasons

Course Outcome 3 (CO3):

1. **Discuss the principles of planning for green construction**
2. **Enumerate various innovative technologies for green buildings**
3. **Differentiate green and smart buildings with examples**

Course Outcome 4(CO4):

1. **Define desertification and its relation with sustainability**
2. **Identify strategies you would consider for implementation of an eco-development programme for Madurai city**
3. **With the knowledge of green construction materials identify suitable measures to minimize environmental impacts in construction projects**

Course Outcome 5 (CO5):

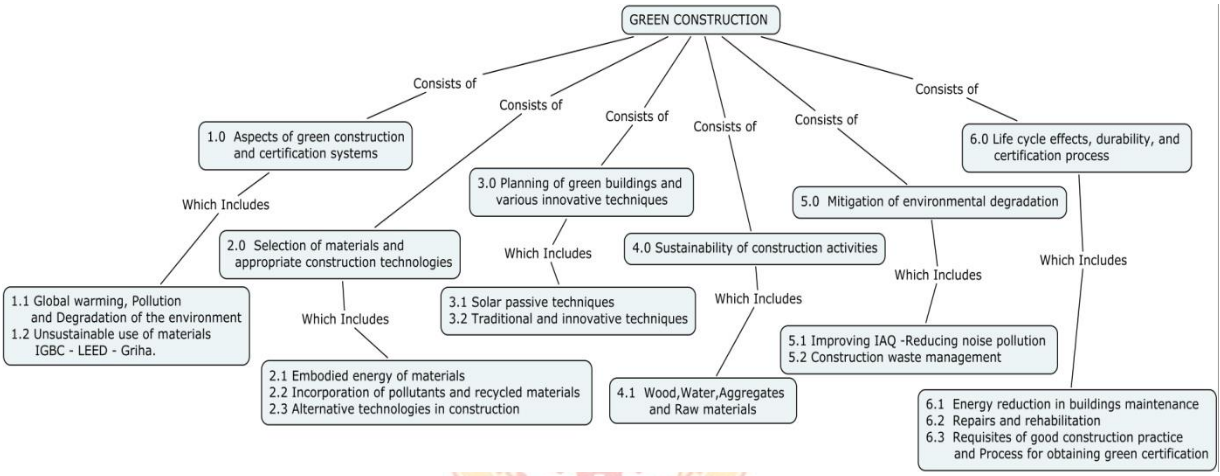
1. **Relate development with environmental degradation**
2. **Suggest suitable scheme to protect and enhance the living environment in and around TCE campus**
3. **For an existing traditional building identify suitable technologies to convert it into a green building with cost effectiveness**

Course Outcome 6 (CO6):

Address Impact of Life cycle effects, durability and certification process

1. Compare GRIHA and IGBC rating systems
2. Discuss the measures/ schemes contributing to good construction practice
3. Enumerate the techniques you would implement for energy saving in your residence.

Concept Map



Syllabus

Aspects of green construction and certification systems: Global warming - Pollution - Degradation of the environment - Unsustainable use of materials - IGBC - LEED - GRIHA. **Selection of materials and appropriate construction technologies:** Embodied energy of materials - incorporation of pollutants and recycled materials - alternative technologies in construction. **Planning of green buildings and various innovative techniques:** Solar passive techniques - traditional and innovative techniques. **Sustainability of construction activities:** Wood - Water - Aggregates - Raw materials. **Mitigation of environmental degradation:** Improving IAQ - reducing noise pollution - construction waste management. **Life cycle effects, durability, and certification process:** Energy reduction in buildings maintenance - Repairs and rehabilitation - Requisites of good construction practice - Process for obtaining green certification.

Reference Books

1. Bureau of Energy Efficiency, "Energy Conservation Building Code 2007", Ministry of Power, Government of India
2. Wright, R.T., and Nebel, B.J., "Environmental Science - Toward a Sustainable Future", 2002, Prentice-Hall of India Private Limited, New Delhi
3. Jagadish, K.S., Venkatarama Reddy, B.V., Nanjunda Rao, K.S., "Alternative Building Materials and Techonologies", 2007, New Age International (P) Limited
4. CII and IGBC, "Training Programme on 'LEED' Green Building Rating System"
5. USGBC, "Green Building Rating System for New Construction and Major Renovations - Version 2.2", 2005
6. Resource Material to be provided by the course handling expert

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	**Aspects of green construction and certification systems**	

Module No.	Topic	No. of Lectures
1.1	Global warming, Pollution & Degradation of the environment	1
1.2	Unsustainable use of materials - IGBC - LEED - Griha	1
2.0	**Selection of materials and appropriate construction technologies**	
2.1	Embodied energy of materials	1
2.2	Incorporation of pollutants and recycled materials	1
2.3	Alternative technologies in construction	1
3.0	**Planning of green buildings and various innovative techniques**	
3.1	Solar passive techniques	1
3.2	Traditional and innovative techniques	1
4.0	**Sustainability of construction activities**	
4.1	Wood , Water, Aggregates & Raw materials	2
5.0	**Mitigation of environmental degradation**	
5.1	Improving IAQ - Reducing noise pollution	1
5.2	Cconstruction waste management	1
6.0	**Life cycle effects, durability, and certification process**	
6.1	Energy reduction in buildings maintenance	1
6.2	Repairs and rehabilitation	1
6.3	Requisites of good construction practice & Process for obtaining green certification	1
	TOTAL	**14 Hrs**

Course Designers:

1. Er. S.P. Srinivasan, MD, ES Consultancy Services, Madurai er.spsvasan@gmail.com

		Category	L	T	P	Credit
14CE1E0	**PRECAST TECHNOLOGY IN BUILDINGS**	PE	1	0	0	1

Preamble

Precast is an industrialized way to build. It means transfer of work from sites to factories which improves productivity, quality and shortens construction time of a building. Precast also has lower lifetime costs than any other building solution. This is possible due to consistent high quality of industrially produced products.

Precast suits well for any type of building namely; residential, commercial, industrial, public etc. This course gives an exposure on the need and importance of using precast technology along with awareness on the technology.

Prerequisite

Knowledge on building construction

Course Outcomes

	On the successful completion of the course, students will be able to:		Expected Attainment level (%)	Expected Proficiency level (grade)
CO1	Compare Precast and cast in-situ technology with implementation challenges	Understand	80	S
CO2	Explain the details of production erection of Hollow core slab with precautions to be taken	Understand	80	S
CO3	Identify the planning aspects for precast projects along with Machinery usage	Understand	80	S
CO4	Enumerate the details of Stacking, Handling, Transportation and Erection of precast elements with precautions	**Apply**	80	S
CO5	Discuss the fixing and jointing in precast buildings with construction sequence	Apply	80	S

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO53.	L	-	-	-	-	-	M	-	-	-	-	-	-	-
CO54.	L	-	-	-	-	-	-	-	-	M	-	-	-	-
CO3	L	-	M	-	-	M	L	-	M	M	M	L	L	L
CO4	L	L	-	M	-	-	L	-	L	M	-	-	L	L
CO5.	L	L	M	M	-	-	-	-	-	M	-	-	L	-

S- Strong; M-Medium; L-Low

Assessment Pattern

S. No.	Bloom's Category	Test 1	End -semester Examination
1.	Remember	20	20
2.	Understand	50	40
3.	Apply	30	40
4.	Analyze	0	0
5.	Evaluation	0	0
6.	Create	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

119. **Mention the need and advantages of using precast technology**
120. **Define the term modular co-ordination mentioning its purpose**
121. **Discuss the challenges that would faced while implementing precast technology in relation to Indian context**
122. **Enumerate the factors you would consider when deciding to implement precast concrete construction**

Course Outcome 2 (CO2):

123. **Explain the details to be noted in the production of hollow core slabs**
124. **Discuss the merits of hollow core slabs over solid slabs mentioning the applications of each**
125. **Enumerate the precautions to be taken in erection of hollow core slabs mentioning its need**

Course Outcome 3 (CO3)

126. **Explain the points you would consider in planning of precast projects**
127. **As an engineer in-charge of precast installation illustrate the provisions and precautions you would consider in jointing of components**
128. **Discuss the machinery used with purpose in precast construction**

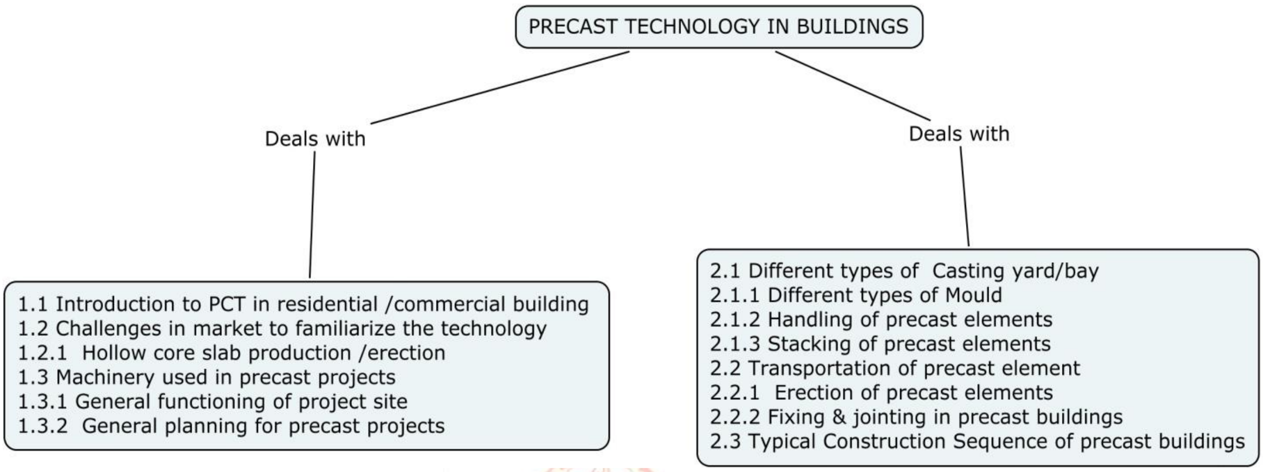
Course Outcome 4 (CO4)

129. **As an engineer discuss the process of stacking of precast units considering a specific unit with precautions to be taken**
130. **Discuss the points to be considered in transportation of precast units**
131. **Discuss the precautions to be taken while erection of precast elements**

Course Outcome 5 (CO5)

132. **As an site engineer identify the sequence of fixing and jointing of wall panels in a buildings**
133. **Discuss the tolerances to be provided while fixing and jointing of precast elements**
134. **Discuss the good practices in jointing of elements**

Concept Map



Syllabus

Introduction to precast technology in residential /commercial building - Challenges in market to familiarize the technology - Hollow core slab production /erection - Machinery used in precast projects - General functioning of project site - General planning for precast projects - Different types of Casting yard/bay - Different types of Mould - Handling of precast elements - Stacking of precast elements -Transportation of precast element - Erection of precast elements - Fixing & jointing in precast buildings - Typical Construction Sequence of precast buildings.

Reference Books

1. IS: 15916 -2011, "Building Design and Erection using Prefabricated Concrete – Code of Practice"
2. NBN EN 1168-2005, "Precast Concrete Products - Hollow Core Slabs"

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	**Precast Technologies in Buildings**	
1.1	Introduction to Precast Technologies in residential and commercial buildings	1
1.2	Challenges in implementation of Precast Technologies	1
1.2.1	Hollow Core slab production/ erection	1
1.3	Machineries used for precast projects	1
1.3.1	General functions of project site	1
1.3.2	General planning for precast projects	1
2.0	**Installation of precast products**	
2.1	Types of casting yards/ bay for precast products	1
2.1.1	Different types of moulds used for precast products	1
2.1.2	Handling of precast elements	1

Module No.	Topic	No. of Lectures
2.1.3	Stacking of precast elements	1
2.2	Transportation of precast elements	1
2.2.1	Erection of precast elements	1
2.2.2	Fixing and jointing in precast buildings	1
2.3	Typical construction sequence of precast buildings	1
	TOTAL	14

Course Designers:

1. **Mr. R. Karunanithi,** karunanithi@lntecc.com
   L&T, Bangalore

14CE1F0 **FRAMING OF STRUCTURES AND OPTIMUM FOUNDATION SYSTEMS**

Category	L	T	P	Credits
PE	1	0	0	1

Preamble

This course is framed to give an overview on the guidelines for idealisation and basic concepts in framing of structures along with optimum foundation systems.

Prerequisite

Knowledge on structural analysis and design of RCC and Steel elements

Course Outcomes

	On the successful completion of the course, students will be able to:		Expected Attainment level (%)	Expected Proficiency level (grade)
CO1	Understand the concept of load transferring mechanism and various components of structures.	Understand	80	S
CO2	Enumerate the details of RCC structural behaviour and their Reinforcement detailing	Understand	80	S
CO3	Enumerate the details of Steel structural behaviour and their Reinforcement detailing	Apply	80	S
CO4	Identify and choose an appropriate foundation systems for a given situation	**Apply**	80	S

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO55.	M	L	L	L	-	-	-	-	-	-	-	-	L	-
CO56.	M	M	L	L	-	-	-	-	-	-	-	L	L	-
CO3.	M	M	L	L	-	-	-	-	-	-	-	L	L	-
CO4.	M	M	M	M	-	-	-	-	-	-	-	-	L	-

S- Strong; M-Medium; L-Low

Assessment Pattern

S. No.	Bloom's Category	Test 1	End -semester Examination
1.	Remember	20	20
2.	Understand	50	40
3.	Apply	30	40
4.	Analyze	0	0
5.	Evaluation	0	0
6.	Create	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

135. **Mention the meaning of framed structures with its purpose**
136. **Discuss the load transfer mechanism in framed structures**
137. **Compare Frame structures with Normal Load bearing Traditional High Rise Building**

Course Outcome 2 (CO2):

138. **Discuss the structural behaviour of framed structures**
139. **Discuss the do's and dont's in detailing of RCC beam**
140. **By means of a sketch explain the points to be considered at the junction of framed structures**

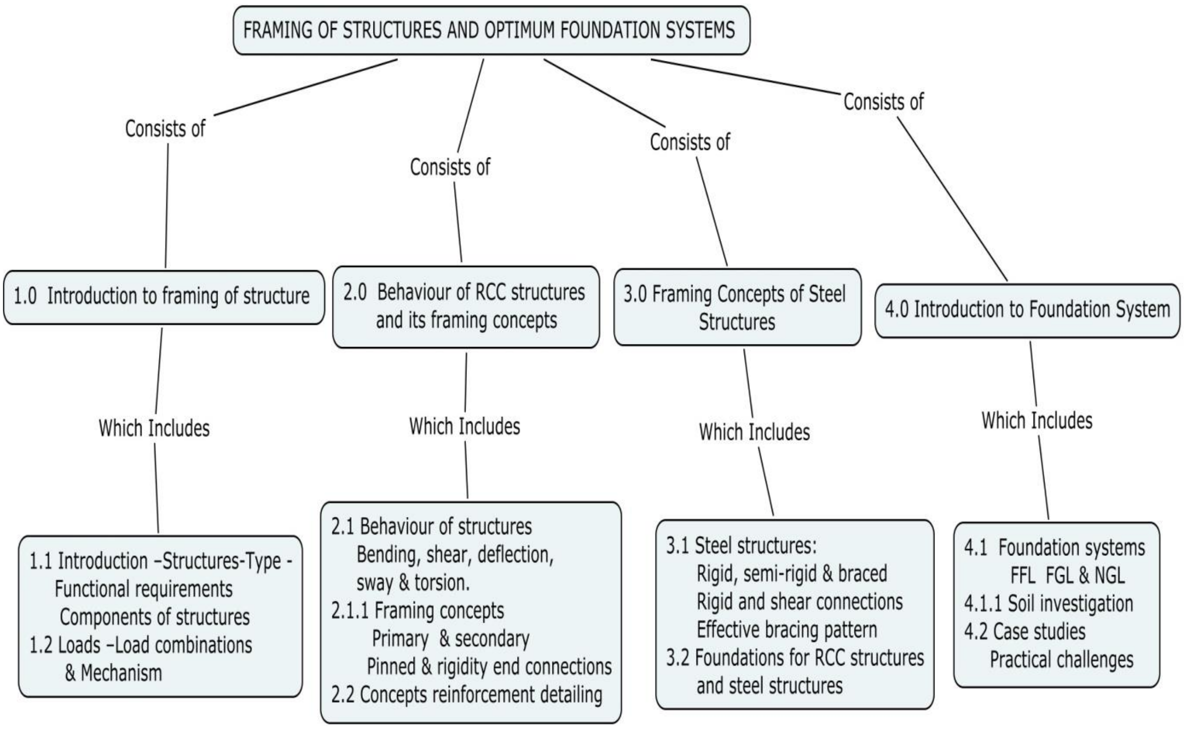
Course Outcome 3 (CO3)

1. **Enumerate the precautions to be noted while designing steel framed structures**
2. **Discuss the behaviour of steel structural members in seismic prone areas**
3. **Draw and explain the junction details to be provided for steel and concrete structures**

Course Outcome 4 (CO4)

141. **List the types of foundation systems to be used in framed structures**
142. **Discuss the guidelines to be used in design of optimum foundation systems for framed structures**
143. **Identify an appropriate foundation system for a framed structure in a seismic prone area and discuss the guidelines for construction**

Concept Map



Syllabus

Introduction to framing of structure: **Introduction –Structures-Types- Practical suitability of framed structures and load bearing structures- Functional requirements of structures and its components. Components of structures – slab, beam, column & footing in RCC structures- Chequered plate flooring/grating, Steel beams & Columns, bracings –vertical & horizontal. Loads – appropriate Loading considerations in various structures. Load path and load transfer mechanism-Engineer's handiness in load transfer in structures- Load combinations.** Behaviour of RCC structures and its framing concepts: **Behaviour of structures – Bending, shear, deflection, sway & torsion- Explanation on control of behaviour of structure's exclusively on engineer's idea. Framing concepts –Rigid framed structures –- Orientation of columns- Beams framing arrangement in floors – Primary beams & secondary beams concepts. Pinned & rigidity end connections Concepts using reinforcement detailing with practical implications in RCC structures.** Framing Concepts of Steel Structures: **Framing concepts – steel structures-Rigid, semi-rigid & braced structures . Rigid and shear connections of steel beams – Effective bracing pattern. Foundation systems –**

overview- Explanation on Foundations for RCC structures and steel structures. Introduction to Foundation System: **Foundation systems –FFL (finished floor levels), FGL (Finished ground level) , NGL (Natural ground level). Soil investigation report study- required inputs from soil investigation. Overall Discussions/Q&A/ Case studies/Practical challenges in design and construction.**

Text Book

1. P. Purushothaman, "Reinforced Concrete Structural Elements: Behaviour, Analysis and Design", 1984, McGraw-Hill Inc.,US
2. S.Unnikrishna Pillai, Devdas Menon, "Reinforced concrete design", 2005, Tata McGraw Hill Publishing Co. Ltd.
3. S.K.Duggal, "Design of Steel Structures", 2000, Tata McGraw Hill Education
4. IS 456: 2000: Code of Practice for Plain and Reinforced Concrete
5. IS 800: 2007: Code of Practice –General construction in steel

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.0	**Introduction to framing of structure**	
1.1	Introduction –Structures-Types- Functional requirements of structures and its components. Components of structures.	1
1.2	Loads – appropriate Loading considerations in various structures. Load path and load transfer mechanism- Load combinations	2
2.0	**Behaviour of RCC structures and its framing concepts**	
2.1	Behaviour of structures – Bending, shear, deflection, sway & torsion.	2
2.2	Framing concepts -Primary beams & secondary beams concepts. Pinned & rigidity end connections	1
2.2.1	Concepts using reinforcement detailing with practical implications in RCC structures	1
3.0	**Framing Concepts of Steel Structures**	
3.1	Framing concepts – steel structures-Rigid, semi-rigid & braced Structures Rigid and shear connections of steel beams – Effective bracing pattern	2
3.2	Foundation systems – overview- Explanation on Foundations for RCC structures and steel structures.	1
4.0	**Introduction to Foundation System**	
4.1	Foundation systems –FFL (finished floor levels), FGL (Finished ground level) , NGL (Natural ground level).	1
4.1.1	Soil investigation report study- required inputs from soil investigation	1
4.2	Overall Discussions/Q&A/ Case studies/Practical challenges in design and construction	2
	TOTAL	14

Course Designers:

1.	**S. Prasanna, Assistant Manager Structural Design, L&T, Chennai**	**s.l.prasanna@gmail.com**

Category L T P Credit

14CE1G0 **LARGE SCALE SYSTEMS** PE 1 0 0 1

Preamble

The aim of this course is to sensitize the undergraduates about the basic concepts of systems engineering methodologies to approach the Socio-Techno problems in a holistic manner. This course will address the basic concepts of cause-effect impacts due to the interrelationships of components and elements of systems in a complex environment.

Course Outcomes

	At the end of the course students will be able to:		Expected Attainment level (%)	Expected Proficiency level (grade)
CO1	Identify tools for process of forecasting and assessment -the indented and unintended impacts on policies and technological solutions	Understand	80	S
CO2	Participate and coordinate in group discussions in organizations.	Understand	80	S
CO3	Understand the components and elements involved in DPR, FR, EIA, EMS and Resettlement & Rehabilitations programs.	Apply	80	S
CO4	Understand the problem situation for higher level policy discussion on any societal and technological issues seamlessly in all domains.	Understand	80	S

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO57.	L	L	---	---	---	M	S	M	---	S	L	L	---	L
CO58.	L	L	---	---	---	---	S	M	---	S	---	---	---	L
CO3	L	M	M	---	---	---	---	---	---	---	---	---	---	L
CO4	L	---	M	---	---	M	S	M	---	S	---	---	---	L

S- Strong; M-Medium; L-Low

Assessment Pattern

S.No	Bloom's Category	End-Semester examination
1.	Remember	20
2.	Understand	40
3.	Apply	40
4.	Analyze	0
5.	Evaluate	0
6.	Create	0

Course Level Learning Objectives

CO1:

1. Define Systems?
2. Distinguish Boolean algebra and Conventional Martix
3. List the steps involved in value system design.
4. Mention the steps involved in Project Planning.
5. State the "Law of requisite theory".

CO2:

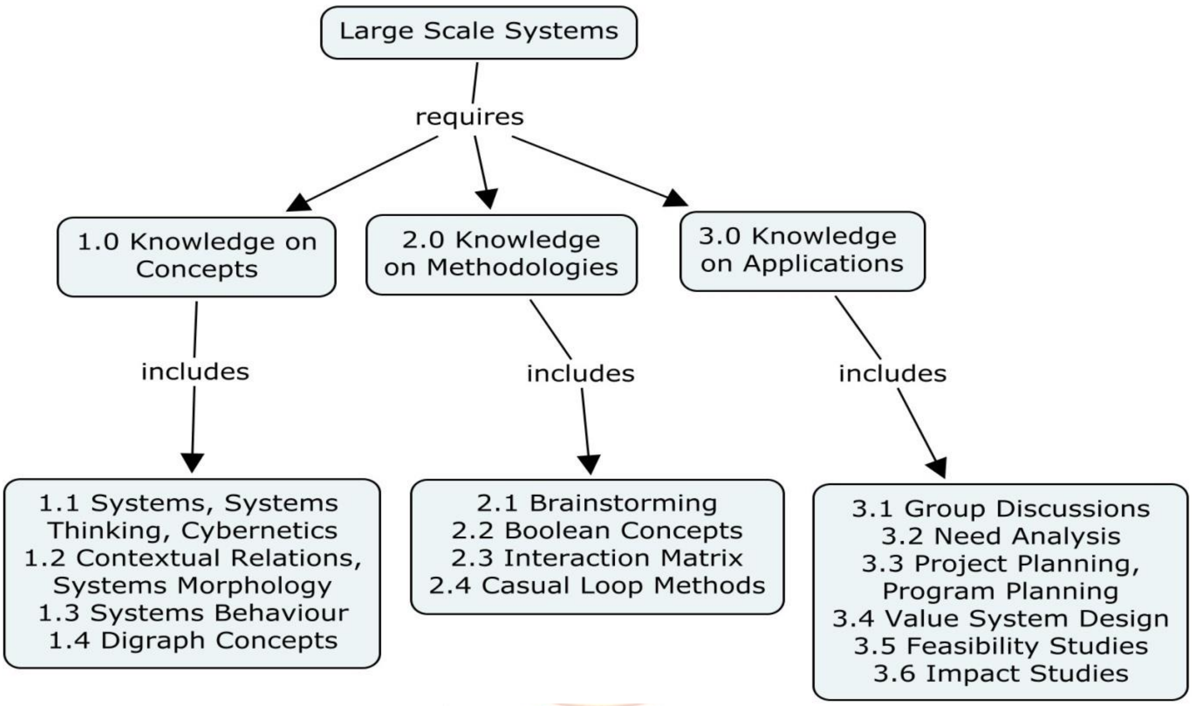
1. Compare System and organism.
2. Discuss various components of System.
3. Explain the System Behaviors with examples.
4. Discuss Constraints Theory with an example.
5. Discuss the components of System Behaviour.

CO3:

1. Narrate any technology that interacts with society environment.
2. Identify the various needs to combat the educational challenges in India.
3. Draw the intent structures for education and energy supply.
4. Discuss the various Objectives, constraints, alterable measures for personal transportation in India in 2050 Interrelations

5. Create a system dynamics model population growth, health, industry and environment.

Concept Map



Course Content and Lecture Schedule

Module No.	Topics	No. of Lectures
1.0	**Knowledge on Concepts**	
1.1	Systems, Systems Thinking, Cybernetics	1
1.2	Contextual Relations, Systems Morphology	1
1.3	Systems Behaviour	1
1.4	Digraph Concepts	1
2.0	**Knowledge of Methodologies**	
2.1	Brain storming	1
2.2	Boolean Concepts	1
2.3	Interaction Matrix	1
2.4	Casual Loop Methods	1
3.0	**Knowledge of Applications**	

3.1	Group Discussions	1
3.2	Need Analysis	1
3.3	Project Planning, Program Planning	1
3.4	Value System Design	1
3.5	Feasibility Studies	1
3.6	Impact Studies	1
	Total Periods	**14**

Syllabus

Systems thinking: Introduction, Problem Situation, Systems & Cybernatics, System Models, Hard/Soft Systems, Soft Systems Methodology, Soft System Examples/Case studies, Ashby's Requisite Variety Theory. **Systems Methodology and Planning:** Halls Morphological Box, Seven Phases of System Engineering, Seven Steps of System Engineering, Program Planning Linkage, Goals, Objectives, Constraints, Alterable, Measures etc., Example: Energy Supply and Demand, Value System Synthesis and Linkage. **Technology Forecasting and Assessment:** Philosophical Basis for TA/TF, Limits to growth model, Methodology in TA/TF- Brainstorming, Delphi, Relevance Tree Techniques, System Dynamics- Examples. **Theory of Constraints:** Fundamental Principles of the theory of Constraints, Understanding and Managing Constraints.

Reference Books

Handouts will be prepared and distributed to students

1. Warfield, J. N. *"An Introduction to Systems Science",* World Scientific, Singapore, 2006.
2. Andrew P. Sage, "Methodology for Large-Scale Systems", McGraw Hill Publication, 1977

Course Designer

Er. S. Ratnavel,

CEO, Sceba Consultancy Services, Madurai ratsiit@gmail.com

14CE1H0	INTERIOR DESIGN	Category	L	T	P	Credit
		PE	1	0	0	1

Preamble

Interior design addresses several issues in living spaces. Interiors play key role in functionality of rooms. This trendy course is designed to create awareness on the need and importance of interiors which would provide responsive and comfortable living to the users.

Course Outcomes

	On the successful completion of the course, students will be able to		Expected Attainment level (%)	Expected Proficiency level (grade)
CO1	Explain concepts of interior design	Apply	80	S
CO2	Design interiors for corporate office, retail shops, residential buildings, hospitality sector, hotels, hospitals - Commercial Interiors	Apply		
CO3	Choose different materials - Color scheme - Lighting for outward looks	Apply	80	S
CO4	Design inside stuff of interiors: services namely	Apply	80	S
CO5	Explain the importance of Project management and costing of interior.	Apply		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1.	M	-	L	-	-	-	-	-	-	L	M	-	L	L
CO2.	M	M	M	M	-	M	-	-	M	-	L	-	L	L
CO3.	L	L	M	L	-	M	-	-	L	-	L	-	L	L
CO4.	M	M	M	L	-	M	-	-	L	-	L	-	L	L
CO5.	L	L	L	-	M	-	-	-	L	M	-	M	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests	Terminal Examination
	1	
Remember	**10**	**10**
Understand	**50**	**40**
Apply	**40**	**50**
Analyze	**--**	**--**
Evaluate	**--**	**--**
Create	**--**	**--**

Course Level Assessment Questions

CO1: Explain concepts of interior design

1. **Explain the types of walls in interiors**
2. **Explain the meaning of formal and informal design of walls**
3. **Define the terms: hardscape and softscape. Explain with examples**

CO2: Design interiors for corporate office, retail shops, residential buildings, hospitality sector, hotels, hospitals - Commercial Interiors - Auditoriums

1. **Define Ergonomics and mention its need in corporate offices**
2. **Explain types of plants that can be used for interior decoration**
3. **Make use of interior concept, design the interior wall, floor and ceiling for a conference hall in an office of size 8m x10m.The ceiling height is 4m and a beam of 45cm depth runs through the shorter span at 3m intervals. Assume the window positions and sizes. Show the construction detail of the interior elements through proper sections**

CO3 : Choose different materials - Color scheme - Lighting for outward looks

1. **What is the difference between a particle board and plywood**
2. **Explain the different types of walls and classify it based on its material and application in interior design.**
3. **Explain the different types of floors and classify it based on its material and application in interior design.**

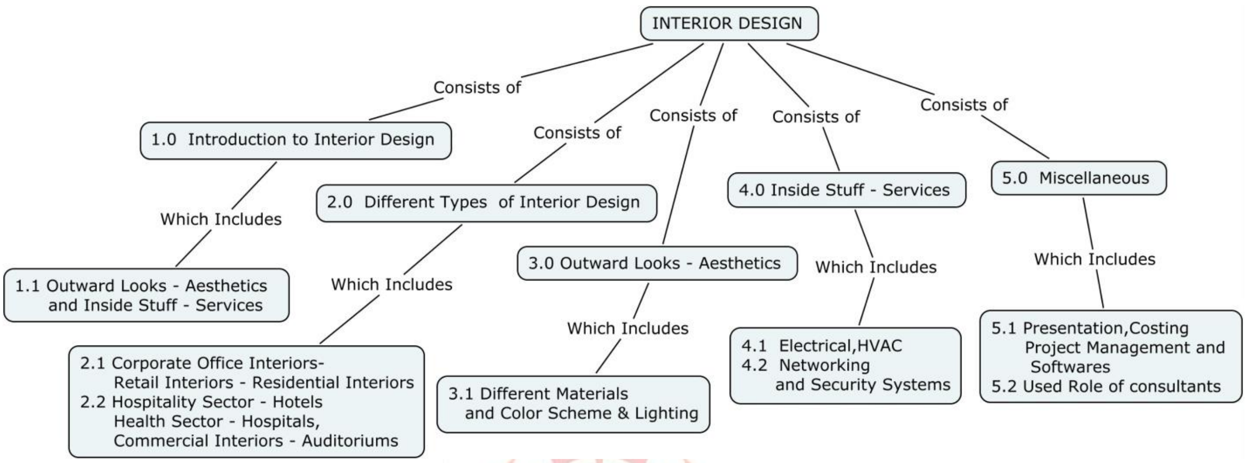
CO4: Design inside stuff of interiors: services namely Electrical - HVAC – Networking - Security systems

1. **Illustrate the interior layout with proper space planning and lighting design for an art gallery of size 10m x 12m and height 4m.Specify the colour, texture and finishes of the wall, floor and ceiling**
2. **Demonstrate the design of a wall mural as a background for the reception area of five star hotel lobby of size 10m x 10m and height 6m, applying the principles the interior design. Assume the necessary details. Specify and illustrate the materials and concept of your mural.**
3. **Expalin the differences between halogen lamps and fluorescent lamps**

CO5: Explain the importance of Project management and costing of interior

1. **What is the need for knowledge on project management in interior design**
2. **What are the softwares to be used for interior designing and project management**
3. **Discuss the role of consultants in interior design**

Concept Map



Syllabus

Introduction to interior design: Outward looks - Aesthetics - Inside stuff - Services. **Different types of Interiors:** Corporate office interiors - Retail interiors - Residential interiors - Hospitality sector – Hotels - Health sector - Hospitals - Commercial interiors - Auditoriums etc. **Outward Looks and Aesthetics:** Different Materials - Color scheme - Lighting. **Inside Stuff and Services:** Electrical - HVAC - Networking - Security systems. **Miscellaneous:** Presentation - Project Management and Costing - Softwares used - Role of consultants.

Reference Books

1. Resource Materials to be provided by the course handling expert
2. Faulkner, S. and Faulkner, R, Inside Today's Home, Rine hart publishing company, Newyork, 1987
3. Stewart Walton, The complete Home Decorator, Portland House New York, 1997
4. Seetharaman, P and Pannu, P. Interior Design and Decoration, CBS publishers and Distributors, New Delhi, 2013
5. Pratap Rao.M, Interior Design principles and practice, Standard Publishers Distribution, Delhi 2015
6. Harriet Goldstein, Art in Everyday life, Oxford and IBH publishing house, 2016

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.0	**Introduction to interior design**	
1.1	Outward Looks - Aesthetics - Inside Stuff – Services	2
2.0	**Different types of interiors**	
2.1	Corporate Office Interiors- Retail Interiors - Residential Interiors	2
2.2	Hospitality Sector – Hotels- Health Sector – Hospitals- Commercial Interiors Auditoriums etc	2
3.0	**Outward looks and Aesthetics**	

Module No.	Topics	No. of Lectures
3.1	Different materials - Color scheme - Lighting	2
4.0	**Inside stuff and Services**	
4.1	Electrical - HVAC	2
4.2	Networking - Security Systems	1
5.0	**Miscellaneous topic related to Interior design**	
5.1	Presentation - Project Management and Costing	2
5.2	Softwares used - Role of consultants	1
	Total hours	**14 Hrs**

Course Designers:

1. Mr. Immanuel B Samuel, Principal Architect Chris Brown Architects, Bangalore sam@cbarchitects.in

14CE1J0	CORROSION OF REINFORCED CONCRETE STRUCTURES	Category	L	T	P	Credit
		PE	1	0	0	1

Preamble

Construction plays a vital role in economic development. The durability of concrete has become a highly discussed topic in global development. Even though several factors are responsible for early distress in reinforced concrete structures it is observed that in majority of cases, it is because of the corrosion of reinforcement. Therefore, basic understanding of corrosion technology for both durability of structure and rehabilitation work is a must. This course gives an overall knowledge on factors influencing, monitoring and methods of control of corrosion affected RC structures.

Prerequisite

Knowledge on Concrete Technology

Course Outcomes

	On the successful completion of the course, students will be able to		Expected Attainment level (%)	Expected Proficiency level (grade)
CO1	Explain the factors influencing reinforcement corrosion in RC structures	Apply	80	S
CO2	Demonstrate the various types of corrosion monitoring methods	Apply	80	S
CO3	Apply appropriate corrosion control methods to distressed concrete structures	Apply	80	S
CO4	Suggest suitable repair and rehabilitation techniques for corrosion affected concrete structures	Apply	80	S

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO59.	S	-	M	-	-	M	-	S	M	L	-	-	L	L
CO60.	S	-	M	-	-	M	-	S	M	L	-	-	L	L
CO3.	M	-	M	-	-	M	-	S	M	L	L	-	L	L
CO4.	M	-	M	-	-	M	-	S	M	L	M	-	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern: Theory cum PracticePart:

Bloom's Category	Test 1	End -semester Examination
Remember	10	10
Understand	20	20
Apply	20	20
Analyze	0	0
Evaluation	0	0
Create	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

4. Mention two factors influencing rebar corrosion in RCC.
5. Discuss the mechanism of corrosion in rebars and discuss the influencing factors.
6. Suggest suitable methods of making concrete buried under polluted ground resistant to corrosion? Justify with reasoning

Course Outcome 2 (CO2):

1. Write the principle of gravimetric method of monitoring of corrosion in concrete structures.
2. Explain the principle of any two methods of monitoring corrosion affected RC structures.
3. Explain the working principle of electrochemical impedance spectroscopy.

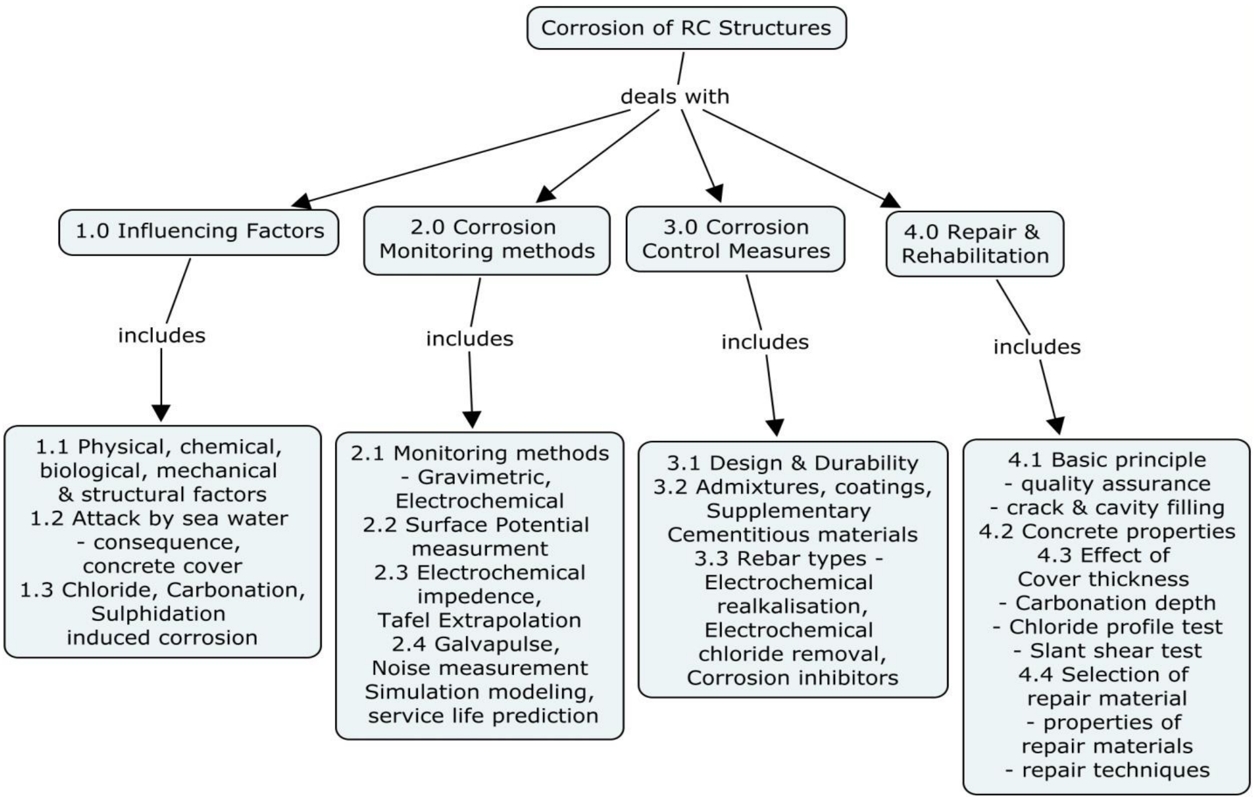
Course Outcome 3(CO3):

1. Define the term service life of structures and mention the need for its prediction.
2. Discuss the properties and uses of various supplementary cementitious materials in concrete.
3. Explain the principle of Electrochemicalrealkalisation mentioning its application.
4. An RCC structure is to be constructed in a marine environment; discuss the various measures you would recommend to make the structure safe against corrosion. Justify with proper reasons.
5. Compare the following techniques: Electrochemical realkalisation and Electrochemical chloride removal discussing the principle behind each and mentioning their applicability.

Course Outcome 4 (CO4):

4. Corrosion of rebars is influenced by cover thickness- justify. Mention the cover thickness to be provided for the following situations: Underwater concreting structure, Normal exposure concrete.
5. An old RCC bridge is showing cracking due to rebar corrosion; discuss the procedure you would adopt while inspecting the structure to diagnose distress and suggest suitable methods of repair to make the structure functionally fit and ensure quality assurance to its users.
6. Explain the factors to be considered in choice of repair materials for corrosion affected RC structures.
7. Discuss the method of diagnosing distress in concrete structures.

Concept Map



Syllabus

Factors Influencing Reinforcement Corrosion: Physical, chemical, biological, mechanical and structural factors, micro cell and macro cell formation in concrete, attack by sea water and consequences of rebar corrosion, initiation and propagation of corrosion, repassivation of steel, concrete cover, chloride binding mechanism, chloride threshold value, carbonation and sulphidation induced corrosion. **Corrosion Monitoring of Concrete Structures:** Health assessment of concrete structures, Methods to assess the deterioration of concrete: Gravimetric Method, Electrochemical methods of corrosion monitoring of rebars: Surface potential measurements, Half-cell potential measurements, Electrical resistance Probe Technique, Instantaneous corrosion rate by Linear Polarization method, Electrochemical Impedance Spectroscopy, Tafel Extrapolation, Galvapulse Method, Noise measurements, Simulation and modeling, Service life prediction. **Corrosion Control Methods For Concrete Structures:** Design and Durability of Concrete, Chemical and mineral admixtures, Coatings to Concrete surface, Supplementary cementitious materials in concrete, Blended cements. Various grades and types of rebars, Electrochemicalrealkalisation, Electrochemical chloride removal, Corrosion inhibiting admixtures. **Repair and Rehabilitation of Concrete Structures:** Basic principle of repair, Concrete removal and surface preparation, Preparation of the reinforcement, quality assurance and the use of materials for concrete, filling cracks and cavities in concrete, Concrete properties : strength, permeability, thermal properties and cracking, Effects due to climate, temperature, chemical corrosion, design and construction errors - Effects of cover thickness and cracking, crack width measurements, carbonation depth, chloride profile tests, Slant-shear tests for new concrete to old concrete bonding, selection of repair materials, Properties of repair materials, Repair Techniques: Guniting and Shotcrete techniques.

Reference Books

1. John P Broomfield, "Corrosion of Steel in Concrete", E & FN SPON, Chapman and Hall, London and New York, 1997.
2. Luca Berttolini, Bernhard Elsener, PietroPedeferri, Rob Polder, "Corrosion of Steel in
3. Concrete, Prevention, Diagnosis, Repair", WILEY-VCH publication, Weinheim, 2004.
4. Kumar Mehta, "Concrete in Marine Environment", Elsevier Applied Science, London and New York, 2003.
5. John New man, Ban SengChoo, "Advanced Concrete Technology", Elsevier Ltd, 2003.
6. Hans Bohni, "Corrosion in Reinforced Concrete Structures", CRC Woodhead Publishing Limited, Cambridge, England, 2005.
7. Mohamed A. El-Reedy, "Steel Reinforced Concrete Structures-Assessment and Repair of Corrosion", CRC Press (Taylor & Francis Group), 2008.
8. M Raupach, B Elsener, R Polder and J Mietz, "Corrosion of Reinforcement in Concrete - Mechanisms, Monitoring, Inhibitors and Rehabilitation techniques", Woodhead Publishing Limited, Cambridge, England 2007.
9. M.S.Shetty, "Concrete Technology - Theory& Practice", S. Chand and Company Limited, New Delhi, 2003.
10. R.N.Raikar, "Leaning from Failures", Publisher - R & D Center (SDCPL), RaikarBhawan, Sector-17, Vashi, Navi Mumbai, 1987.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.0	**Factors Influencing Reinforcement Corrosion**	
1.1	Physical, chemical, biological, mechanical and structural factors, micro cell and macro cell formation in concrete	1
1.2	Attack by sea water and consequences of rebar corrosion initiation and propagation of corrosion, depassivation of steel, concrete cover	1
1.3	Chloride binding mechanism, chloride threshold value, carbonation and sulphidation induced corrosion	1
2.0	**Corrosion Monitoring of Concrete Structures**	

2.1	Health assessment of concrete structures, Methods to assess the deterioration of concrete: Gravimetric Method, Electrochemical methods of corrosion monitoring of rebars	1
2.2	Surface potential measurements, Half-cell potential measurements, Electrical resistance Probe Technique	1
2.3	Instantaneous corrosion rate by Linear Polarization method, Electrochemical Impedance Spectroscopy, Tafel Extrapolation	1
2.4	Galvapulse Method, Noise measurements, Simulation and modeling, Service life prediction	1
3.0	**Corrosion Control Methods For Concrete Structures**	
3.1	Design and Durability of Concrete	1
3.2	Chemical and mineral admixtures, Coatings to Concrete surface, Supplementary cementitious materials in concrete, Blended cements	1
3.3	Various grades and types of rebars, Electrochemical realkalisation, Electrochemical chloride removal, Corrosion inhibiting admixtures	1
4.0	**Repair and Rehabilitation of Concrete Structures**	
4.1	Basic principle of repair, Concrete removal and surface preparation, Preparation of the reinforcement, quality assurance and the use of materials for concrete, filling cracks and cavities in concrete	1
4.2	Concrete properties : strength, permeability, thermal properties and cracking, Effects due to climate, temperature, chemical corrosion, design and construction errors	1
4.3	Effects of cover thickness and cracking, crack width measurements, carbonation depth, chloride profile tests, Slant-shear tests for new concrete to old concrete bonding	1
4.4	Selection of repair materials, Properties of repair materials, Repair Techniques: Guniting and Shotcrete techniques	1
	Total	14

Course Designers:

1. Dr. V. Saraswathy, corrsaras@rediffmail.com

   CECRI, Karaikudi