CURRICULUM AND DETAILED SYLLABI FOR

B.E DEGREE (Civil Engineering) PROGRAMME

FIRST SEMESTER TO EIGHTH SEMESTER

For the Students admitted from the academic year 2022-2023 onwards

THIAGARAJAR COLLEGE OF ENGINEERING

(A Government Aided Autonomous Institution affiliated to Anna University)

MADURAI – 625 015

Approved in 65th Academic Council Meeting on 27.05.2023

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 (PEOs) 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

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 multi various 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 fundamentalsandanengineeringspecializationtothesolutionofcomplexengineering 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

Schedule of Courses

SEM	Theory / Theory Cum Practical / Practical									CDIO Courses	Audit Courses	Credits
	1	2	3	4	5	6	7	8	9	10	11	12
I	22MA110 Calculus for Engineers BSC (4)	23PH120 Physics BSC(3)	22CH130 Chemistry BSC (3)	22EG140 English HSMC (2)	22ES150 Engineering Exploration ESC (2)	22ME160 Engineering Graphics ESC (4)	22EG170 English Laboratory HSMC (1)	22PH180 Physics Laboratory BSC (1)	22CH190 Chemistry Laboratory BSC (1)	-	-	21
II	22CE210 Matrices and Ordinary Differential Equations BSC (4)	22CE220 Engineering Mechanics ESC (4)	22CE230Surveying PCC (3)	22CE240 Programming for Problem Solving ESC (3)	22CE250 Building Materials and Technology PCC (3)	-	22CE270 Workshop ESC (1)	22CE280 Survey Laboratory PCC (1)	-	-	22CHAA0 Audit Course - I	19
III	22CE310 Fourier Series and Partial Differential Equations BSC (4)	22CE320 Mechanics of Solids PCC (3)	22CE330 Fluid Mechanics PCC (3)	22CE340 Water Supply Engineering PCC (3)	PSE – I (3)	-	22CE370 C Programming Laboratory ESC (1)	22CE380 Digital Survey Laboratory PCC (1)	-	22ESXXX Design Thinking ESC (3)	-	21
IV	22CE410 Probability, Statistics and Numerical Methods BSC (4)	22CE420 Structural Analysis PCC (3)	22CE430 Hydraulics and Hydraulic Machinery PCC (3)	22CE440 Wastewater Engineering PCC (3)	PSE – II (3)	-	22CE470 Mechanics Laboratory PCC (1)	22CE480 Computer Aided Drafting Lab PCC (1)	22CE490 Project Management HSMC (3)	-	22CHAB0 Audit Course - II	21
V	22CE510 Soil Mechanics PCC (3)	22CE520 Design of Steel Elements PCC (3)	22CE530 Concrete Technology ESC (4)	Inter- disciplinary Elective OEC (3)	PSE – III (3)	PSE – IV (3)	22CE570 Materials Testing Laboratory PCC (1)	22CE580 Project Planning Laboratory PCC (1)	22CE590 Core Area Project - I (3)	-	-	24
VI	22CE610 Foundation Engineering PCC (3)	22CE620 Design of Reinforced Concrete Elements PCC (3)	22CE630 Highway & Railway Engineering PCC (3)	22CE640 Accounting & Finance HSMC (3)	Basic Science Elective OEC (3)	22EG660 Professional Communication HSMC (2)	22CE670 Fluid Mechanics and Machinery Laboratory PCC (1)	22CE680 Analysis and Design Laboratory PCC (1)	22CE690 Core Area Project – II (3)	PEES – I (3)	-	25
VII	22CE710 Construction Management PCC (2)	22CE720 Irrigation and Water Resources Engineering PCC (3)	PSE – V (3)	PEES – II (3)	PEES – III (3)	22CE760Estimation and Costing Laboratory PCC (1)	22CE770 Environmental Engineering Laboratory PCC (1)	22CE780 Soil and Highway EngIneering. Laboratory PCC (1)	22CE790 Core Area Project - III (3)	-	-	20
VIII	PSE – VI (3)	PSE – VII (3)	-	-	-	-	-	-	22CE890 Core Area Project - IV (3)	-	-	09
											Total Credits	160

Credit Distribution for B E Civil Engineering Programme

S. No	Category		Credits	
			Regular Admission	Lateral Entry Admission
A	**Foundation Courses (FC)**		**54 – 66**	**24 - 36**
	a.	Humanities and Social Sciences including Management Courses (HSMC)	9- 12	09 - 12
	b.	Basic Science Courses (BSC)	24 – 27	06 - 09
	c.	Engineering Science Courses (ESC)	21 – 27	12 - 15
B	**Professional Core Courses (PCC)**		**55**	**45**
C	**Professional Elective Courses (PEC)**		**24 – 39**	**24 - 39**
	a.	Programme Specific Electives (PSE)	15 – 24	15 – 24
	b.	Programme Electives for Expanded Scope (PEES)	9 – 15	9 – 15
D	**Open Elective Courses (OEC)**		**6 – 12**	**6 – 12**
	a.	Interdisciplinary Elective (IE)	3 – 6	3 – 6
	b.	Basic Science Elective (BSE)	3 – 6	3 – 6
E	**Project Work**		**12**	**12**
F	**Internship and Mandatory Audit Courses ae per Regulatory authorities**		**Non-Credit (Not included for CGPA)**	
	Minimum Credits to be earned for the award of the Degree		**160**	**120**
			From A to E and the successful completion of F	

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E Degree (Civil Engineering) Programme

COURSES OF STUDY

(For the candidates admitted from 2022-2023 onwards)

FIRST SEMESTER

Course code	Name of the Course	Category **	No. of Hours / Week L	T	P	Credits
THEORY						
22MA110	Calculus for Engineers	BSC	3	1	0	4
22PH120	Physics	BSC	3	0	0	3
22CH130	Chemistry	BSC	3	0	0	3
22EG140	Technical English	HSMC	2	0	0	2
22ES150	Engineering Exploration	ESC	1	1	0	2
THEORY CUM PRACTICAL						
22ME160	Engineering Graphics	ESC	3	0	2	4
PRACTICAL						
22EG170	English Laboratory	HSMC	0	0	2	1
22PH180	Physics Laboratory	BSC	0	0	2	1
22CH190	Chemistry Laboratory	BSC	0	0	2	1
Total			**15**	**2**	**8**	**21**

SECOND SEMESTER

Course code	Name of the Course	Category **	No. of Hours / Week L	T	P	Credits
THEORY						
22CE210	MATRICES AND ORDINARY DIFFERENTIAL EQUATIONS	BSC	3	1	0	4
22CE220	ENGINEERING MECHANICS	ESC	3	1	0	4
22CE230	SURVEYING	PCC	3	0	0	3
22CE240	PROGRAMMING FOR PROBLEM SOLVING	ESC	3	0	0	3
22CHAA0	ENVIRONMENTAL SCIENCE	ESC	1	0	1	-
THEORY CUM PRACTICAL						
22CE250	BUILDING MATERIALS AND TECHNOLOGY	PCC	2	0	2	3
PRACTICAL						
22CE270	WORKSHOP	PCC	0	0	2	1
22CE280	SURVEYLABORATORY	PCC	0	0	2	1
Total			**15**	**2**	**7**	**19**

THIRD SEMESTER

Course code	Name of the Course	Category **	No. of Hours / Week			Credits
			L	T	P	
THEORY						
22CE310	FOURIER SERIES AND PARTIAL DIFFERENTIAL EQUATIONS	BSC	3	1	0	4
22CE320	MECHANICS OF SOLIDS	PCC	3	0	0	3
22CE330	FLUID MECHANICS	PCC	3	0	0	3
22CE340	WATER SUPPLY ENGINEERING	PCC	3	0	0	3
22CEXXX	PROGRAM SPECIFIC ELECTIVE - I	PSE	3	0	0	3
PRACTICAL						
22CE370	C PROGRAMMING LABORATORY	ESC	0	0	2	1
22CE380	DIGITAL SURVEY LABORATORY	PCC	0	0	2	1
22ESXXX	DESIGN THINKING	ESC	3	0	0	3
Total			**18**	**1**	**4**	**21**

FOURTH SEMESTER

Course code	Name of the Course	Category **	No. of Hours / Week			Credits
			L	T	P	
THEORY						
22CE410	PROBABILITY, STATISTICS AND NUMERICAL METHODS	BSC	3	1	0	4
22CE420	STRUCTURAL ANALYSIS	PCC	2	1	0	3
22CE430	HYDRAULICS AND HYDRAULIC MACHINERIES	PCC	3	0	0	3
22CE440	WASTEWATER ENGINEERING	PCC	3	0	0	3
22CE490	PROJECT MANAGEMENT	HSMC	2	1	0	3
22CEXXX	PROGRAM SPECIFIC ELECTIVE - II	PSE	3	0	0	3
PRACTICAL						
22CE470	STRUCTURAL MECHANICS LABORATORY	PCC	0	0	2	1
22CE480	COMPUTER AIDED DRAFTING LABORATORY	PCC	0	0	2	1
Total			**16**	**3**	**4**	**21**

FIFTH SEMESTER

Course code	Name of the Course	Category **	No. of Hours / Week			Credits
			L	T	P	
THEORY						

22CE510	SOIL MECHANICS	PCC	3	0	0	3
22CE520	DESIGN OF STEEL ELEMENTS	PCC	3	0	0	3
22CE530	CONCRETE TECHNOLOGY	ESC	4	0	0	4
22XXX	INTER - DISPLINARY ELECTIVE	OEC	3	0	0	3
22CEXXX	PROGRAM SPECIFIC ELECTIVE - III	PSE	3	0	0	3
22CEXXX	PROGRAM SPECIFIC ELECTIVE - IV	PSE	3	0	0	3
PRACTICAL						
22CE570	MATERIALS TESTING LABORATORY	ESC	0	0	2	1
22CE580	PROJECT PLANNING LABORATORY	PCC	0	0	2	1
22CE590	CORE AREA PROJECT - I	PCC	0	0	6	3
Total			**19**	**0**	**10**	**24**

SIXTH SEMESTER

Course code	Name of the Course	Category **	No. of Hours / Week			Credits
			L	T	P	
THEORY						
22CE610	FOUNDATION ENGINEERING	PCC	3	0	0	3
22CE620	DESIGN OF REINFORCED CONCRETE ELEMENTS	PCC	3	0	0	3
22CE630	HIGHWAY AND RAILWAY ENGINEERING	PCC	3	0	0	3
22CE640	ACCOUNTING AND FINANCE	HSMC	2	1	0	3
22XXX	BASIC SCIENCE ELECTIVE	OEC	3	0	0	3
22XXX	PROGRAM ELECTIVES FOR EXPANDED SCOPE - I	PEES	3	0	0	3
THEORY CUM PRACTICAL						
22EG660	PROFESSIONAL COMMUNICATION	HSMC	0	1	2	2
PRACTICAL						
22CE670	FLUID MECHANICS AND MACHINERY LABORATORY	PCC	0	0	2	1
22CE680	ANALYSIS AND DESIGN LABORATORY	PCC	0	0	2	1
22CE690	CORE AREA PROJECT - II	PCC	0	0	6	3
Total			**17**	**2**	**12**	**25**

SEVENTH SEMESTER

Course code	Name of the Course	Category **	No. of Hours / Week			Credits
			L	T	P	
THEORY						
22CE710	CONSTRUCTION MANAGEMENT	PCC	2	0	0	2
22CE720	IRRIGATION AND WATER RESOURCES ENGINEERING	PCC	3	0	0	3
22CEXXX	PROGRAM SPECIFIC ELECTIVE - V	PSE	3	0	0	3
22CEXXX	PROGRAM ELECTIVES FOR EXPANDED SCOPE - II	PEES	3	0	0	3
22CEXXX	PROGRAM ELECTIVES FOR EXPANDED SCOPE - III	PEES	3	0	0	3
PRACTICAL						
22CE760	ESTIMATION AND COSTING LABORATORY	PCC	0	0	2	1
22CE770	ENVIRONMENTAL ENGINEERING LABORATORY	PCC	0	0	2	1
22CE780	SOIL AND HIGHWAY ENGINEERING LABORATORY	PCC	0	0	2	1
22CE790	CORE AREA PROJECT - III	PCC	0	0	6	3
Total			**14**	**0**	**12**	**20**

EIGHTH SEMESTER

Course code	Name of the Course	Category **	No. of Hours / Week			Credits
			L	T	P	
THEORY						
22CEXXX	PROGRAM SPECIFIC ELECTIVE - VI	PSE	3	0	0	3
22CEXXX	PROGRAM SPECIFIC ELECTIVE - VII	PSE	3	0	0	3
PRACTICAL						
22CE890	CORE AREA PROJECT - IV	PCC	0	0	6	3
Total			**6**	**0**	**6**	**9**

Professional Elective Courses

a. **Program Specific Electives**

Sl. No	Course code	Name of the Course	Category **	No. of Hours / Week			Credits
				L	T	P	
1	22CEPA0	FINITE ELEMENT ANALYSIS	PSE	3	0	0	3
2	22CEPB0	DYNAMICS OF STRUCTURES AND EARTHQUAKE ENGINEERING	PSE	3	0	0	3
3	22CEPC0	PRESTRESSED CONCRETE	PSE	3	0	0	3
4	22CEPD0	BRIDGE ENGINEERING	PSE	3	0	0	3
5	22CEPE0	FRACTURE MECHANICS	PSE	3	0	0	3
6	22CEPF0	INSTRUMENTATION IN CIVIL ENGINEERING	PSE	3	0	0	3
7	22CEPG0	DISASTER MITIGATION AND MANAGEMENT	PSE	3	0	0	3
8	22CEPH0	REPAIR AND REHABILITATION OF STRUCTURES	PSE	3	0	0	3
9	22CEPJ0	ADVANCED REINFORCED CONCRETE DESIGN	PSE	3	0	0	3
10	22CEPK0	COMPUTATIONAL METHODS IN STRUCTURAL ANALYSIS	PSE	3	0	0	3
11	22CEPL0	STRUCTURAL MASONRY	PSE	3	0	0	3
12	22CEPM0	MUNICIPAL SOLID WASTE MANAGEMENT	PSE	3	0	0	3
13	22CEPN0	AIR AND NOISE POLLUTION MANAGEMENT	PSE	3	0	0	3
14	22CEPP0	WASTE MANAGEMENT	PSE	3	0	0	3
15	22CEPQ0	ENVIRONMENTAL IMPACT ASSESSMENT	PSE	3	0	0	3
16	22CEPR0	BASICS OF REMOTE SENSING	PSE	3	0	0	3
17	22CEPS0	GROUND WATER MANAGEMENT	PSE	3	0	0	3
18	22CEPT0	ENGINEERING HYDROLOGY	PSE	3	0	0	3
19	22CEPU0	GROUND IMPROVEMENT TECHNIQUES	PSE	3	0	0	3
20	22CEPV0	TRAFFIC ENGINEERING AND SAFETY	PSE	3	0	0	3
21	22CEPW0	AIRWAYS AND WATERWAYS	PSE	3	0	0	3
22	22CEPX0	GEOTECHNIQUES FOR INFRASTRUCTURE	PSE	3	0	0	3

b. Program Electives for Expanded Scope

Sl. No	Course code	Name of the Course	Category **	No. of Hours / Week L	T	P	Credits
1	22CERA0	ASEISMIC DESIGN OF STRUCTURES	PEES	3	0	0	3
2	22CERB0	EXPERIMENTAL TECHNIQUE AND INSTRUMENTATIONS	PEES	3	0	0	3
3	22CERC0	COMPUTER AIDED DESIGN	PEES	3	0	0	3
4	22CERD0	ANTI-TERRORISM DESIGN OF STRUCTURES	PEES	3	0	0	3
5	22CERE0	DESIGN OF REINFORCED CONCRETE STRUCTURES	PEES	3	0	0	3
6	22CERF0	DESIGN OF STEEL STRUCTURES	PEES	3	0	0	3
7	22CERG0	DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES	PEES	3	0	0	3
8	22CERH0	COLD FORMED STEEL STRUCTURAL DESIGN	PEES	3	0	0	3
9	22CERJ0	RESOURCE AND ENERGY RECOVERY FROM WASTES	PEES	3	0	0	3
10	22CERK0	INDUSTRIAL WASTE WATER MANAGEMENT	PEES	3	0	0	3
11	22CERL0	SUSTAINABLE MANAGEMENT OF URBAN ECOLOGY	PEES	3	0	0	3
12	22CERM0	ENVIRONMENTAL POLICIES AND LEGISLATION	PEES	3	0	0	3
13	22CERN0	ENVIRONMENTAL REMOTE SENSING	PEES	3	0	0	3
14	22CERP0	SURFACE AND GROUND WATER QUALITY MODELING	PEES	3	0	0	3
15	22CERQ0	COMPUTATIONAL INTELLIGENCE FOR HYDROSYSTEMS	PEES	3	0	0	3
16	22CERR0	CONSTRUCTION EQUIPMENT MANAGEMENT	PEES	3	0	0	3
17	22CERS0	QUANTITATIVE METHODS IN MANAGEMENT	PEES	3	0	0	3
18	22CERT0	CONTRACTS AND ARBITRATION	PEES	3	0	0	3
19	22CERU0	LEAN CONSTRUCTION	PEES	3	0	0	3
20	22CERV0	MATERIAL PROCUREMENT AND MANAGEMENT	PEES	3	0	0	3
21	22CERW0	MANAGEMENT OF HUMAN RESOURCES, SAFETY AND QUALITY	PEES	3	0	0	3
22	22CERX0	TRAFFIC ENGINEERING AND MANAGEMENT	PEES	3	0	0	3
23	22CERY0	PAVEMENT ANALYSIS AND DESIGN	PEES	3	0	0	3
24	22CERZ0	DESIGN OF FOUNDATION AND SUBSTRUCTURE	PEES	3	0	0	3

c. Electives under Minor Vertical

Sl. No	Course code	Name of the Course	Category **	No. of Hours / Week			Credits
				L	T	P	
1	22CEQA0	BUILDING DESIGN	PSE	3	0	0	3
2	22CEQB0	SUSTAINABLE BUILDING MATERIALS	PSE	3	0	0	3
3	22CEQC0	URBAN PLANNING AND DEVELOPMENT	PSE	3	0	0	3
4	22CEQD0	GREEN AND SUSTAINABLE BUILDING	PSE	3	0	0	3
5	22CEQE0	BUILDING MATERIALS AND TECHNIQUES	PSE	3	0	0	3
6	22CEQF0	BUILDING ESTIMATION AND VALUATION	PSE	2	1	0	3

BSC : Basic Science Courses
ESC : Engineering Science Courses
PCC : Professional Core Courses
PSE : Program Specific Electives
PEES : Program Electives for Expanded Scope

L : Lecture T : Tutorial P : Practical
Note:
1 Hour Lecture/Tutorial is equivalent to 1 credit
2 Hours Practical is equivalent to 1 credit

PROCEDURE FOR AWARDING MARKS FOR INTERNAL ASSESSMENT

For all the theory courses, laboratory courses, theory courses with laboratory component and project work the continuous assessment shall be awarded as per the procedure given below:

THEORY COURSES

Two assessments each carrying 100 marks shall be conducted during the semester by the Department / College concerned. The total marks obtained in all assessments put together out of 200, shall be proportionately reduced for 40 marks and rounded to the nearest integer (This also implies equal weightage to the two assessments).

Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total** Internal Assessment
Individual Assignment / Case Study / Seminar / Mini Project / any other experiential Learning	Written Test	Individual Assignment / Case Study / Seminar / Mini Project / any other experiential Learning	Written Test	
40	60	40	60	200*

**The weighted average shall be converted into 40 marks for internal Assessment.*

A minimum of two internal assessments will be conducted as a part of continuous assessment. Eachinternalassessmentistobeconductedfor100marksandwillhavetobedistributedintwo parts viz., Individual Assignment/Case study/Seminar/Mini project and Test with each having a weightage of 40% and 60% respectively. The tests shall be in written mode. The total internal assessment marks of 200 shall be converted into a maximum of 40 marks and rounded to the nearest integer.

LABORATORY COURSES

The maximum marks for Internal Assessment shall be 60 marks in case of practical courses. Every practical exercise / experiment shall be evaluated based on conduct of experiment / exercise and records are to be maintained. There shall be at least one test. The criteria for arriving at the Internal Assessment marks of 60 is as follows: 75 marks shall be awarded for successful completion of alltheprescribedexperimentsdoneintheLaboratoryand25marks for the test. The total mark shall be converted into a maximum of 60 marks and rounded to the nearest integer.

Internal Assessment (100 Marks)*	
Evaluation of Laboratory Observation, Record	Test
75	25

** Internal assessment marks shall be converted into 60 marks*

THEORY COURSES WITH LABORATORY COMPONENT / LABORATORYCOURSES WITH THEORYCOMPONENT

Weightage of internal assessment and end semester Examination marks will be 50% each. The distribution of marks for the theory and laboratory components in the internal assessments and end semester Examination for different types of courses are provided in the table.

L	T	P	C	Internal		End semester Examination
				Assessment 1	Assessment 2	
1	0	4	3	Laboratory (25%)	Theory (25%)	Laboratory only (50%)
1	0	2	2	Laboratory (25%)	Theory (25%)	Laboratory only (50%)
2	0	2	3	Theory (25%)	Laboratory (25%)	Theory (25%) Laboratory (25%)
3	0	2	4	Theory (25%)	Laboratory (25%)	Theory (35%) Laboratory (15%)
2	0	4	4	Theory (25%)	Laboratory (25%)	Theory (15%) Laboratory (35%)

The procedure for the conduct of internal assessments for theory and laboratory components shall be as per the clause 12.1 and 12.2 respectively.*
The weighted average shall be converted into 50 marks for internal Assessment.

** Autonomous Colleges may adopt Theory courses with Laboratory component and Laboratory courses with Theory component with different L T P C formats and the weightage of marks for Theory and Laboratory components may be fixed in proportion to lecture and practical contact periods. However, the weightage for internal and end semester Examination marks will remain as 50%each.*

PROJECT WORK / INTERNSHIP AND LABORATORY COURSES

For the Project Work / Internship and Laboratory Courses fixed grading procedure shall be followed.

PASSING REQUIREMENTS

A student who secures not less than 50% of total marks prescribed for the course [Internal Assessment + End semester University Examinations] with a minimum of 45% of the marks prescribed for the end-semester University Examination, shall be declared to have passed the course and acquired the relevant number of credits. This is applicable for both theory and laboratory courses (including project work).
If a student fails to secure a pass in a theory course / laboratory course (except electives), the student shall register and appear only for the end semester Examination in the subsequent semester. In such case, the internal assessment marks obtained by the student in the first appearance shall be retained and considered valid for all subsequent attempts till the student secures a pass. However, from the third attempt onwards if a student fails to obtain pass marks (IA + End Semester Examination), then the student shall be declared to have passed the Examination if he/she secures a minimum of 50% marks prescribed for the University end semester Examinations alone.

AWARD OF LETTER GRADES

The award of letter grades will be decided based on relative grading principle. The relative grading is applicable to ONLY those students who have passed the Examination as per the passing requirements enumerated above. For those students who have not passed the Examination, Reappearance (U) shall be awarded as shown in the below Table.

For those students who have passed the course, the relative grading shall be done. The marks of those students who have passed only shall be inputted in the software developed for relative grading. The evolved relative grading method normalizes the results data using the BOX-COX transformation method and computes the grade range for each course separately and awards the grade to each student. For a given course, if the students' strength is greater than 30, the relative grading method shall be adopted. However, if the students' strength is less than or equal to 30 then the fixed grading shall be followed with the grade range as specified below.

O	A+	A	B+	B	C	*U*
91 - 100	81 - 90	71 - 80	61 - 70	56 - 60	50 – 55	< 50

The performance of a student shall be reported using letter grades, each carrying certain points as detailed below:

Letter Grade	Grade Points*
O (Outstanding)	**10**
A+ (Excellent)	**9**
A (Very Good)	**8**
B+(Good)	**7**
B (Average)	**6**
C (Satisfactory)	**5**
U (Re-appearance)	**0**
SA (Shortage of Attendance)	**-**
WD (Withdrawal)	**-**

A student is deemed to have passed and acquired the corresponding credits in a particular course if he/she obtains any one of the following grades: “O”, “A+”, “A”, “B+”,“B”, “C”.

‘SA’ denotes shortage of attendance and hence prevented from writing the end semester Examinations. ‘SA’ will appear only in the result sheet.

“U” denotes that the student has failed to pass in that course. “**WD**” denotes **withdrawal** from the exam for the particular course. The grades U and WD will figure both in the Grade Sheet as well as in the Result Sheet. In both cases, the student has to appear for the End Semester Examinations.

If the grade U is given to **Theory Courses**/ **Laboratory Courses it is not required to satisfy the** attendance requirements, but has to appear for the end semester Examination and fulfil the passing requirements to earn a pass in the respective courses.

If the grade U is given to **EEC (Employability Enhancement Course) (except Project Work), which are evaluated only through internal assessment,** the student shall register for the course again in the subsequent semester, fulfil the passing requirements to earn pass in the course. However, attendance requirement need not be satisfied.

CLASSIFICATION OF THE DEGREE AWARDED FIRST CLASS WITH DISTINCTION

A student who satisfies the following conditions shall be declared to have passed the Examination in **First class with Distinction:**

- Should have passed the Examination in all the courses of all the eight semesters (10 Semesters in case of Mechanical (Sandwich)and6semestersinthecaseofLateral Entry) in the student’s First Appearance within **five** years (S ix years in the case of Mechanical (Sandwich) and Four years in the case of Lateral Entry). Withdrawal from Examination will not be considered as an appearance.
- Should have secured a CGPA of not less than**8.50**.
- One year authorized break of study (if availed of) is included in the five years (Six years in the case of Mechanical (Sandwich) and four years in the case of lateral entry) for award of First class with Distinction.
- Should NOT have been prevented from writing end semester Examination due to lack of attendance in any semester.

FIRST CLASS:

A student who satisfies the following conditions shall be declared to have passed the Examination in **First class:**

- Should have passed the Examination in all the courses of all eight semesters (10 Semesters in case of Mechanical (Sandwich) and 6 semesters in the case of Lateral Entry) **within five years**. (Six years in case of Mechanical (Sandwich) and Four years in the case of Lateral Entry).

- One year authorized break of study (if availed of) or prevention from writing the End Semester Examination due to lack of attendance (if applicable) is included in the duration of five years (Six years in case of Mechanical (Sandwich) and four years in the case of lateral entry) for award of First class.
- Should have secured a CGPA of not less than **6.50.**

SECOND CLASS:

All other students who qualify for the award of the degree shall be declared to have passed the Examination in **Second Class**.

The corresponding specific changes are to be made to B.Arch. / M.Arch. / M.Plan. / MBA / M.Sc.(5years).

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THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015
B.E Degree (Civil Engineering) Programme
SCHEME OF EXAM INATIONS
(For the candidates admitted from 2022-2023 onwards)

FIRST 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	22MA110	Calculus for Engineers	3	40	60	100	27	50
2	22PH120	Physics	3	40	60	100	27	50
3	22CH130	Chemistry	3	40	60	100	27	50
4	22EG140	Technical English	3	40	60	100	27	50
5	22ES150	Engineering Exploration	3	40	60	100	27	50
THEORY CUM PRACTICAL								
6	22ME160	Engineering Graphics	3	50	50	100	25	50
PRACTICAL								
7	22EG170	English Laboratory	3	60	40	100	18	50
8	22PH180	Physics Laboratory	3	60	40	100	18	50
9	22CH190	Chemistry Laboratory	3	60	40	100	18	50

SECOND 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	22CE210	MATRICES AND ORDINARY DIFFERENTIAL EQUATIONS	3	40	60	100	27	50
2	22CE220	ENGINEERING MECHANICS	3	40	60	100	27	50
3	22CE230	SURVEYING	3	40	60	100	27	50

4	22CE240	PROGRAMMING FOR PROBLEM	3	40	60	100	27	50
THEORY CUM PRACTICAL								
5	22CE250	BUILDING MATERIALS AND TECHNOLOGY	3	50	50	100	22.5	50
PRACTICAL								
6	22CE270	WORKSHOP	3	60	40	100	18	50
7	22CE280	SURVEYLABORAT ORY	3	60	40	100	18	50

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	22CE310	FOURIES SERIES AND PARTIAL DIFFERRBTIAL EQUAIONS	3	40	60	100	27	50
2	22CE320	MECHANICS OF SOLIDS	3	40	60	100	27	50
3	22CE330	FLUID MECHANICS	3	40	60	100	27	50
4	22CE340	WATER SUPPLY ENGINEERING	3	40	60	100	27	50
PRACTICAL								
5	22CE370	C PROGRAMMING LABOATORY	3	60	40	100	18	50
6	22CE380	DIGITAL SURVEY LABORATORY	3	60	40	100	18	50

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	22CE410	PROBABILITY, STATISTICS AND NUMERICAL METHODS	3	40	60	100	27	50
2	22CE420	STRUCTURAL ANALYSIS	3	40	60	100	27	50

3	22CE430	HYDRAULICS AND HYDRAULIC MACHINERIES	3	40	60	100	27	50
4	22CE440	WASTEWATER ENGINEERING	3	40	60	100	27	50
5	22CE490	PROJECT MANAGEMENT	3	40	60	100	27	50
				PRACTICAL				
6	22CE470	STRUCTURAL MECHANICS LABORATORY	3	60	40	100	18	50
7	22CE480	COMPUTER AIDED DRAFTING LABORATORY	3	60	40	100	18	50

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	22CE510	SOIL MECHANICS	3	40	60	100	27	50
2	22CE520	DESIGN OF STEEL ELEMENTS	3	40	60	100	27	50
3	22CE530	CONCRETE TECHNOLOGY	3	40	60	100	27	50
				PRACTICAL				
4	22CE570	MATERIALS TESTING LABORATORY	3	60	40	100	18	50
5	22CE580	PROJECT PLANNING LABORATORY	3	60	40	100	18	50
6	22CE590	CORE AREA PROJECT – I	-	40	60	100	27	50

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	22CE610	FOUNDATION ENGINEERING	3	40	60	100	27	50
2	22CE620	DESIGN OF REINFORCED CONCRETE ELEMENTS	3	40	60	100	27	50
3	22CE630	HIGHWAY AND RAILWAY ENGINEERING	3	40	60	100	27	50
4	22CE640	ACCOUNTING AND FINANCE	3	40	60	100	27	50
THEORY CUMPRACTICAL								
5	22EG660	PROFESSIONAL COMMUNICATION	3	50	50	100	22.5	50
PRACTICAL								
6	22CE670	FLUID MECHANICS AND MACHINERY LABORATORY	3	60	40	100	18	50
7	22CE680	ANALYSIS AND DESIGN LABORATORY	3	60	40	100	18	50
8	22CE690	CORE AREA PROJECT – II	-	40	60	100	27	50

SEVETH 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	22CE710	CONSTRUCTION MANAGEMENT	3	40	60	100	27	50
2	22CE720	IRRIGATION AND WATER RESOURCES ENGINEERING	3	40	60	100	27	50
PRACTICAL								
4	22CE760	ESTIMATION AND COSTING LABORATORY	3	60	40	100	18	50
5	22CE770	ENVIRONMENTAL ENGINEERING LABORATORY	3	60	40	100	18	50
6	22CE780	SOIL AND HIGHWAY ENGINEERING LABORATORY	3	60	40	100	18	50
7	22CE790	CORE AREA PROJECT – III	-	40	60	100	27	50

EIGHTH 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	22CEXXX	PROGRAM SPECIFIC ELECTIVE - VI	3	40	60	100	27	50
2	22CEXXX	PROGRAM SPECIFIC ELECTIVE - VII	3	40	60	100	27	50
3	22CE890	CORE AREA PROJECT – IV	-	40	60	100	27	50

22MA110	CALCULUS FOR ENGINEERS

Category	L	T	P	Credit
BSC	3	1	0	4

Preamble

This course aims to provide technical competence of modeling engineering problems using calculus. This course is implements the calculus concepts geometrically, numerically, algebraically and verbally. Students will apply the main tools for analyzing and describing the behavior of functions of single and multi-variables: limits, derivatives, integrals of single and multi-variables to model and solve complex engineering problems using analytical methods and MATLAB.

Prerequisite

NIL

Course Outcomes

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

CO's	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Cognize the concept of functions, limits and continuity	TPS2	75	70
CO2	Compute derivatives and apply them in solving engineering problems	TPS3	70	65
CO3	Employ partial derivatives to find maxima minima of functions of multi variables	TPS3	70	65
CO4	Demonstrate the techniques of integration to find the surface area of revolution of a curve.	TPS3	70	65
CO5	Utilize double integrals to evaluate area enclosed between two curves.	TPS3	70	65
CO6	Apply triple integrals to find volume enclosed between surfaces	TPS3	70	65

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

<table>
<tr><th rowspan="2">CO</th><th colspan="6">Assessment 1</th><th colspan="6">Assessment 2</th><th colspan="4" rowspan="2">Terminal
(%)</th></tr>
<tr><th colspan="3">Written Test 1 (%)</th><th colspan="3">Assignment 1 (%)</th><th colspan="3">Written Test 2 (%)</th><th colspan="3">Assignment 2 (%)</th></tr>
<tr><th>TPS</th><th>1</th><th>2</th><th>3</th><th>1</th><th>2</th><th>3</th><th>1</th><th>2</th><th>3</th><th>1</th><th>2</th><th>3</th><th>1</th><th>2</th><th>3</th><th>TOTAL (%)</th></tr>
<tr><td>CO1</td><td colspan="3">20%</td><td colspan="3" rowspan="3">50%</td><td colspan="3">-</td><td colspan="3">-</td><td>-</td><td>10%</td><td>-</td><td>10%</td></tr>
<tr><td>CO2</td><td colspan="3">32%</td><td colspan="3">-</td><td colspan="3">-</td><td>-</td><td>-</td><td>16%</td><td>16%</td></tr>
<tr><td>CO3</td><td colspan="3">36%</td><td colspan="3">-</td><td colspan="3">-</td><td>-</td><td>-</td><td>18%</td><td>18%</td></tr>
<tr><td>CO4</td><td colspan="3">12%</td><td colspan="3">-</td><td colspan="3">39%</td><td colspan="3" rowspan="3">50%</td><td>-</td><td>-</td><td>25%</td><td>25%</td></tr>
<tr><td>CO5</td><td colspan="3">-</td><td colspan="3">-</td><td colspan="3">35%</td><td>-</td><td>-</td><td>17%</td><td>17%</td></tr>
<tr><td>CO6</td><td colspan="3">-</td><td colspan="3">-</td><td colspan="3">26%</td><td>-</td><td>-</td><td>14%</td><td>14%</td></tr>
<tr><td>MATLAB</td><td colspan="3">-</td><td colspan="3">50%</td><td colspan="3">-</td><td colspan="3">50%</td><td></td><td></td><td></td><td></td></tr>
<tr><td>TOTAL</td><td colspan="3">100%</td><td colspan="3">100%</td><td colspan="3">100%</td><td colspan="3">100%</td><td>-</td><td>10%</td><td>90%</td><td>100 %</td></tr>
</table>

* Assignment 1: (i)Application Problems in CO1, CO2 and CO3 (50%).
(ii) MATLAB Onramp & Introduction to symbolic Math with MATLAB (50%).
**Assignment 2: (i) Application Problems in CO4, CO5 and CO6 (50%).
(ii) Application problems using MATLAB. (50%).
***Terminal examination should cover all Course Outcomes in the appropriate TPS Scale level.

Syllabus

DIFFERENTIAL CALCULUS
Functions - New functions from old functions - Limit of a function - Continuity - Limits at infinity - Derivative as a function - Maxima and Minima of functions of one variable – Mean value theorem - Effect of derivatives on the shape of a graph- Application problems in engineering using MATLAB.

FUNCTIONS OF SEVERAL VARIABLES
Function of several variables- Level curves and level surfaces - Partial derivatives – Chain rule - Maxima and minima of functions of two variables –Method of Lagrange's Multipliers - Application problems in engineering using MATLAB.[9 hours]

INTEGRAL CALCULUS:
The definite integral – Fundamental theorem of Calculus – Indefinite integrals and the Net Change Theorem – Improper integrals – Area of surface of revolution - Volume of solid of revolution - Application problems in engineering using MATLAB.

MULTIPLE INTEGRALS:
Iterated integrals-Double integrals over general regions-Double integrals in polar coordinates-Applications of double integrals (density, mass, moments & moments of inertia problems only)-triple integrals- triple integrals in cylindrical coordinates- triple integrals in spherical coordinates-change of variables in multiple integrals - Application problems in engineering using MATLAB.

Text Books

1) James Stewart, "Calculus Early Transcendentals", 9e, Cengage Learning, New Delhi, 2019.
DIFFERENTIAL CALCULUS: [Sections: 1.3, 2.2, 2.5, 2,6,2.8, 4.1, 4.2 and 4.3.]
FUNCTIONS OF SEVERAL VARIABLES: [Sections: 14.1,14.3,14.5,14.7 and 14.8.]
INTEGRAL CALCULUS: [Sections: 5.2, 5.3, 5.4, 7.8, 8.2 and 6.2.]
MULTIPLE INTEGRAL: [Sections: 15.1-15.4, 15.6-15.9]
2) Lecture Notes on Calculus Through Engineering Application Problems and Solutions, Department of Mathematics, Thiagarajar College of Engineering, Madurai.

Reference Books and web resources

1. George B. Thomas, "Thomas Calculus: early Transcendentals", 14^{th}e ,Pearson,New Delhi, 2018.
2. Howard Anton, IrlBivens and Stephen Davis, “Calculus: Early Transcendentals”, 12^{th}e, John Wiley&Sons, 2021.
3. Kuldeep Singh, "Engineering Mathematics Through Appplications",2^{nd}e, Blooms berry publishing, 2019,
4. Kuldip S. Rattan, Nathan W. Klingbeil, Introductory Mathematics for Engineering Applications, 2^{nd} e John Wiley&Sons , 2021.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**DIFFERENTIAL CALCULUS**	
1.1	Functions and New functions from old functions	2
1.2	Limit of a function &Continuity of a function	1
	Tutorial	1
1.3	Limits at infinity	1
1.4	Derivative as a function	2
	Tutorial	1
1.5	Maxima and Minima of functions of single variable	2
1.6	The Mean value theorem and effect of derivatives on the shape of a graph of a function	1
	Tutorial	1
1.7	Application problems in engineering using MATLAB	1
2	**FUNCTIONS OF SEVERAL VARIABLES**	
2.1	Level curves and level surfaces	2
2.2	Partial derivatives – Chain rule	1
	Tutorial	1
2.3	Maxima and minima of functions of two variables	2
2.4	Method of Lagrange’s Multipliers	1
	Tutorial	1
2.5	Application problems in engineering using MATLAB	1
3	**INTEGRAL CALCULUS**	
3.1	The definite integral	1
3.2	Fundamental theorem of Calculus	2
	Tutorial	1
3.3	Indefinite integrals and the Net Change Theorem	1
3.4	Improper integrals	2
	Tutorial	1
3.5	Area of surface of revolution	1
3.6	Volume of solid of revolution.	2
3.7	Application problems in engineering using MATLAB	1
4	**MULTIPLE INTEGRALS**	
4.1	Iterated integrals	1
4.2	Double integrals over general regions	2
	Tutorial	1
4.3	Double integrals in polar coordinates	1
4.4	Applications of double integrals (density, mass, moments & moments of inertia problems only)	2
	Tutorial	1
4.5	Triple integrals	1
4.6	Triple integrals in cylindrical coordinates	1
4.7	Triple integrals in spherical coordinates	1

Module No.	Topic	No. of Periods
	Tutorial	1
4.8	Change of variables in multiple integrals	1
4.9	Application problems in engineering using MATLAB	1
	Total	**48**

Course Designer(s):

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22PH120	PHYSICS (Common to all branches)

Category	L	T	P	Credit
BSC	3	0	0	3

Preamble

The course work aims in imparting fundamental knowledge of mechanics, oscillations and waves and optics, electromagnetism and quantum mechanics which are essential in understanding and explaining engineering devices.

Prerequisite

None

Course Outcomes

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

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency (%)	Expected Attainment Level (%)
CO1	Apply the vector calculus approach and Newton's law in polar coordinates to solve problems in mechanics	TPS3	85	80
CO2	Solve for the solutions and describe the behaviour of a damped harmonic oscillator and waves.	TPS3	85	80
CO3	Introduce Schrodinger equation to arrive at the energy values of particle in a box and linear harmonic oscillator	TPS3	85	80
CO4	Use the principle of quantum mechanics for quantum mechanical tunnelling, quantum confinement and quantum computation	TPS2	85	80
CO5	Use the laws of electrostatics and magnetostatics to explain electromagnetic wave propagation	TPS3	85	80
CO6	Explain the fundamentals of optical phenomena and its applications	TPS2	85	80

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assessment - I						Assessment - II						Terminal Exam (%)		
	CAT – I (%)			Assg. I * (%)			CAT – II (%)			Assg. II * (%)					
TPS Scale / CO	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	8	15	22										6	6	10
CO2	8	10	15	100									4	3	10
CO3	4	5	13				-	-	15				-	2	15
CO4							4	15	-	100			4	6	-
CO5							-	-	35				-	3	15
CO6							16	15	-				6	10	-
Total	**20**	**30**	**50**	**100**			**20**	**30**	**50**	**100**			**20**	**30**	**50**

*Assignment I, II –Quiz/ Puzzle/ Case analysis/ Problem-solving/ Presentation/ Writing tasks

Syllabus

Mechanics of Particles:
Scalars and vectors under rotation transformation - Coordinate system - Cartesian, Polar, Spherical, Cylindrical - Newton's second law of motion - Forces in nature - Central forces - Conservative and non-conservative forces - Work - Energy theorem - Conservation of angular momentum - Satellite manoeuvres

Oscillations and Waves:
Simple harmonic oscillators - Energy decay in a Damped harmonic oscillator - Q factor- Impedance matching- Wave groups and group velocity - Non dispersive Transverse and Longitudinal waves - Waves with dispersion - Water waves - Acoustic waves - Earthquake and Tsunami waves

Quantum Mechanics:
Wave nature of particles - wave function - probability current density and expectation values - Schrodinger wave equation - Uncertainty principle - Particle in a box in 1D - Linear harmonic oscillator - Quantum tunnelling – Quantum confinement in 0D, 1D, 2D systems - Scanning tunnelling microscope - Quantum Cascade lasers - Quantum computation (qubit) - Entanglement - Teleportation

Electromagnetic Fields and Waves:
Electric potential and Electric field of a charged disc - Magnetic Vector potential - Maxwell's equation - Equation of continuity – Poynting Vector - Energy and momentum of EM waves - CT/MRI scan

Optics:
Ray paths in inhomogeneous medium and its solutions – Applications - Fibre optics - Numerical Aperture& Acceptance angle - Fibre optic sensors - Liquid Level & Medical Applications - Interference in non-reflecting films - Fabry-Perot interferometer - Diffraction - Fraunhofer diffraction due to double slit

Text Books

1. Principles of Physics, Halliday, Resnick and JearlWalker, 9thEdition, Wiley, 2011.
2. PaulA.TiplerandG.Mosca,PhysicsforScientistsandEngineers,6thEdition,Freeman,2008.

Reference Books

MECHANICS OF PARTICLES
1. Paul A.TiplerandGeneMosca, Physics for Scientists and Engineers, 6thEdition, Freeman, 2008 (Chapters– 4, 9 & 10).
2. Manoj K. Harbola, Engineering Mechanics, 2ndEdition, Cengage, 2018.

OSCILLATIONS AND WAVES
1. Paul ATipler, Gene Mosca, Physics for Scientists and Engineers, 6thEdition, Freeman, 2008 (Chapters– 14 & 15).
2. HJ Pain, ThePhysicsof Vibrations&Waves,6thEd., John Wiley 2005 (Ch. 2, 5, 6).

ELECTROMAGNETIC FIELDS AND WAVES
1. Principles of Physics, Halliday, ResnickandJearlWalker, 9thEdition, Wiley, 2011 (Chapters - 23, 24, 32 & 33)
2. PMFishbane,StephenG.Gasiorowicz,StephenTThornton,PhysicsforScientists&Engineerswith ModernPhysics,3rdEdition,Pearson,2005(Chapters-26, 28, 31, 34).

OPTICS

1. Paul A.Tipler and GeneMosca, Physics for Scientists and Engineers, 6thEdition, Freeman, 2008 (Chapters– 31 & 33).
2. AjoyGhatak, Optics, 5thEdition, Tata McGraw Hill, 2012 (Chapters – 3, 18, 20)

QUANTUM MECHANICS

1. Paul A.Tipler and GeneMosca, Physics for Scientists and Engineers, 6thEdition, Freeman, 2008 (Chapters– 34 & 35).
2. 2.StephenT.ThorntonandAndrewRex, Modern Physics for Scientists and Engineers, 4thEdition, Cengage, 2013. (Chapters- 5 & 6).
3. R. Shankar, Fundamentals of Physics– I, II, Yale University Press, 2014, 2016.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Mechanics of Particles**	**8**
1.1	Scalars and vectors under rotation transformation	2
1.2	Coordinate system - Cartesian, Polar, Spherical, Cylindrical	2
1.3	Newton's second law of motion - Forces in nature - Central forces	2
1.4	Conservative and non-conservative forces - Work - Energy theorem - Conservation of angular momentum - Satellite manoeuvres	2
2	**Oscillations and Waves**	**6**
2.1	Simple harmonic oscillators - Energy decay in a Damped harmonic oscillator	2
2.2	Q factor- Impedance matching – Wave groups and group velocity	2
2.3	Non-dispersive transverse and Longitudinal waves	1
2.4	Waves with dispersion- Water waves -Acoustic waves – Earthquake and Tsunami waves	1
3	**Quantum Mechanics**	**10**
3.1	Wave nature of particles - wave function -probability current density and expectation values -Uncertainty principle - Schrodinger wave equation	4
	CAT-I after 18 contact hours	
3.2	Applications - Particle in a box in 1D – Linear harmonic oscillator	2
3.3	Quantum tunnelling – Quantum confinement in 0D, 1D, 2D systems - Scanning tunnelling microscope – Quantum Cascade lasers – Quantum computation (qubit) – Entanglement - Teleportation	4
4	**Electromagnetic Fields and Waves**	**6**
4.1	Electric potential and Electric field of a charged disc	1
4.2	Magnetic Vector potential – Maxwell's Equations	2
4.3	Equation of continuity- Poynting vector - Energy and momentum of EM waves	2
4.4	CT/MRI scan	1
5	**Optics**	**6**
5.1	Ray paths in inhomogeneous medium & its solutions –Applications – Fiber optics	2
5.2	Numerical Aperture& Acceptance angle - Fiber optic sensors - Liquid Level & Medical Applications	2
5.3	Interference in non-reflecting films - Fabry- Perot interferometer - Diffraction - Two slit Fraunhoffer diffraction	2
	CAT-II after 18 contact hours	
	Total	**36**

Course Designers:

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22CH130	CHEMISTRY

Category	L	T	P	Credit
BSC	3	0	0	3

Preamble

The objective of this course is to bestow basic concepts of chemistry and its applications in engineering domain. It imparts knowledge on properties and treatment methods of water, spectroscopic techniques and their applications. This course provides exposure on electrochemical techniques for corrosion control, surface coatings and energy storage devices and also emphasis the properties and applications of engineering materials.

Prerequisite

Nil

Course Outcomes

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

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	Explain the essential water quality parameters of water	TPS2	70	70
CO2	Determine hardness of water and identify suitable water treatment method	TPS3	70	70
CO3	Explain the electrochemical process involved in energy storage devices and corrosion of metals	TPS2	70	70
CO4	Interpret the electrochemical principles in modern energy storage devices and corrosion control methods	TPS3	70	70
CO5	Identify the appropriate spectroscopic technique for various applications	TPS3	70	70
CO6	Select the materials based on the properties for Engineering applications	TPS3	70	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal					
TPS Scale	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
CO1	4	20	0										2	8				
CO2	4	0	20										2	4	10			
CO3	4	20	0										2	8				
CO4	8	0	20										2	4	10			
CO5							12	20	20				6	8	10			
CO6							8	20	20				6	8	10			

*Terminal examination should cover all Course Outcomes in the appropriate TPS Scale level.

CO	Assignment 1*						Assignment 2*					
TPS Scale	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
CO1												
CO2			20									
CO3												
CO4			20									
CO5									20			
CO6									20			

*Assessment type: Quiz / Test /Presentation

Syllabus

Water: Water-sources- physical - characteristics - alkalinity - hardness of water **–** types -determination of hardness by EDTA method. Boiler trouble-Softening of water:Internal and External treatment methods. Waste water treatment process. **Electrochemical technologies for energy storage and surface engineering:** Electrochemistry and Energy storage: Basics of electrochemistry. Batteries **-** Primary and Secondary batteries. Fuel cells.Hydrogen generation and storage. Corrosion and Surface Engineering**–**Basics **–**Corrosion - causes- factors- types - corrosion of metal and computer components- Corrosion control. Electroplating - Electroless process. **Spectroscopic technique and applications:** Principle, instrumentation, and applications: X-ray-diffraction - UV**–**Visible spectroscopy- Atomic Absorption Spectroscopy - Fluorescence spectroscopy - Inductively Coupled Plasma - Optical Emission Spectroscopy- Infra-red spectroscopy - Nuclear magnetic resonance spectroscopy**. Engineering materials:** Bonding and their influences on the property of materials - melting point - brittleness, ductility **–** thermal, electrical, and ionic conductivity - optical **–** magnetic properties, hydrophobic, hydrophilic. **Polymer composites** - structure and properties-applications.**Ceramics and advanced ceramics** - types-properties-applications-**Nano-materials –** Synthesis, structure, and properties **–**applications.

Text Book

1. P.C. Jain and Monica Jain, A Textbook of Engineering Chemistry, DhanpatRai publications, New Delhi, 16th edition, 2015.

Reference Books & web resources

1. S.S. Dara and S.S. Umare, “A Textbook of Engineering Chemistry”, S.Chand& Company, 12th Edition, Reprint, 2013.
2. ShashiChawla, “ A text book of Engineering Chemistry”, DhanpatRai& Co.(pvt) ltd, 3rd edition, reprint 2011.
3. C. N. Banwell and E.M. McCash, “Fundamentals of Molecular Spectroscopy”, Tata McGraw-Hill (India), 5th Edition, 2013.

4. W.F. Smith, Principles of Materials Science and Engineering: An Introduction; Tata Mc-Graw Hill, 2008.
5. V. Raghavan, Introduction to Materials Science and Engineering; PHI, Delhi, 2005.
6. M. Akay, 2015, An introduction to polymer matrix composites,” from: https://www.academia.edu/37778336/An_introduction_to_polymer_matrix_composites

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Water**	
1.1	Importance of water, sources, standards for drinking water, (WHO, BIS & ICMR standards) physical, chemical & biological characteristics, Alkalinity (principle only)	1
1.2	Hardness of water - types, units. Determination of hardness by EDTA method and numerical problems	2
1.3	**boiler trouble:** Scale and sludge formation, boiler corrosion, priming and foaming, caustic embrittlement	1
1.4	**Internal treatment methods:** Carbonate, Phosphate, Colloidal, Calgon conditioning	1
1.5	**softening of water:** External treatment methods:Lime-soda process (concept only), zeolite process,ion exchange process	2
1.6	Desalination- reverse osmosis, electro dialysis, solar and multistage flash distillation, nano-filtration	1
1.7	Waste water treatment – primary, secondary, and tertiary treatment	1
2	**Electrochemical technologies for energy storage and surface engineering**	
2.1	**Electrochemistry and Energy storage**: Introduction– Basics of electrochemistry – Redox process, EMF	1
2.2	**Energy storage –** Batteries, Battery quality parameters	1
2.3	Primary battery – Dry cell and Alkaline cell	1
2.4	Secondary battery – Lead-acid battery, Lithium-ion battery	1
2.5	Fuel cells – Fundamentals, types and applications. Hydrogen generation and storage	1
2.6	**Corrosion and Surface Engineering**- Basics –Corrosion - causes-factors- types	1
2.7	chemical, electrochemical corrosion (galvanic, differential aeration), corrosion of metal and computer components-	1
2.8	Corrosion control - material selection and design aspects - electrochemical protection – sacrificial anode method and impressed current cathodic method	1
2.9	Electroplating –Introduction, Process, Applications (Gold and nickel plating). Electroless plating – Principle, process, Applications (PCB manufacturing)	1
3	**Spectroscopic technique and applications**	
3.1	Introduction to Electromagnetic Radiation, Types of atomic and molecular spectra	1
3.2	***Principle, Instrumentation and Applications:*** X-ray-diffraction	1
3.3	UV–Visible spectroscopy,Atomic Absorption Spectroscopy	2
3.4	Fluorescence spectroscopy, Inductively Coupled Plasma - Optical	2

Module No.	Topic	No. of Periods
	Emission Spectroscopy	
3.5	Infra-red spectroscopy	2
3.6	Nuclear magnetic resonance spectroscopy – Magnetic resonance imaging	1
4	**Engineering materials**	
4.1	Bonding and its influence on the property of materials	1
4.2	Properties of materials- melting point - brittleness, ductility - thermal, electrical and ionic conductivity	1
4.3	optical – magnetic properties, hydrophobic, hydrophilic	1
4.4	**Polymer composites** - structure and properties	1
4.5	applications -automotive, aerospace, marine, biomedical, and defense	1
4.6	**Ceramics and advanced ceramics** - types-properties	1
4.7	applications- medicine, electrical, electronics, space	1
4.8	**Nano-materials –** Synthesis, structure and properties	1
4.9	applications - sensors, drug delivery, photo and electro-catalysis, and pollution control	1
	Total	36

Course Designer(s):

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22EG140	TECHNICAL ENGLISH

Category	L	T	P	Credit
HSMC	2	0	0	2

Preamble

The course aims at fostering the students' ability to communicate effectively in various academic, professional, and social settings through oral and written forms. Besides imparting the basic skills such as Listening, Speaking, Reading and Writing (LSRW), significant emphasis is placed on enriching their analytical, descriptive, and creative skills, enabling them to develop and demonstrate a holistic English language proficiency.

Prerequisite

NIL

Course Outcomes

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

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
CO1	**Relate** the fundamentals of language in terms of vocabulary, grammar and pronunciation in technical communication.	Understand	60%	70%
CO2	**Infer** ideas from technical and general contexts by identifying main ideas, specific details, predicting and note-making.	Understand	60%	70%
CO3	**Make use of** language in professional and social contexts with clarity and conciseness.	Apply	60%	70%
CO4	**Identify** specific contexts in technical writing, where appropriate lexical and grammatical functions are applied	Apply	60%	70%
CO5	**Develop** the skills such as understanding, evaluating, analysing and summarising the text and graphical representations.	Apply	60%	70%
CO6	**Organise** ideas with coherence, cohesion and precision in formal written communication	Apply	70%	80%

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	Assessment 1						Assessment 2						Terminal (%)		
	Written Test 1 (%)			Assignment 1 (%)			Written Test 2 (%)			Assignment 2 (%)					
TPS	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1		24%									-		-	10%	-
CO2		34%			100%						-		-	20%	
CO3			14%						24%		-		-	-	20%
CO4			14%		-				34%				-	-	10%
CO5			14%		-						100%		-	-	20%
CO6					-				42%				-	-	20%
TOTAL	100%			100%			100%			100%			100%		

* Assignment 1:Speaking activities in CO1, CO2, and CO3 (100%).
**Assignment 2: Writing activities in CO4, CO5, and CO6 (100%).
***Terminal examination should cover all Course Outcomes in the appropriate TPS Scale level.

Syllabus:

MODULE- I - Basics of Language (CO1)
Vocabulary - Word Building, Prefix, Suffix and Root Words, Basics of Grammar – Parts of Speech, Tenses, Phonetics - Phonemes, Syllables and Stress.

MODULE- II – Reading (CO2)
Reading - Skimming and Scanning of Short Comprehension Passages and Answering Questions or Cloze exercises based on the text prescribed for extensive reading, Note-Making.

MODULE- III – Functional English (CO3)
Framing Questions (WH and Yes/No), Modals, Manual Writing, Recommendations Writing, Agenda and Minutes of Meeting.

MODULE-IV – Technical Notions (CO4)
Technical Notions - Subject-Verb Agreement, Relative Clause, Phrasal Verbs, Impersonal Passive Voice, Noun Compounds, Classifications and Definitions, Cause and Effect, Purpose and Function, Numerical Adjectives.

MODULE-V – Analytical Writing and Business Correspondence (CO5 & CO6)
Summary Writing, Interpretation of Graphics, Jumbled Sentences, Paragraph Writing, Formal Letters (Seeking Permission for Industrial Visit/internship/Bonafide), E-mail Writing (BEC Vantage Writing Task I)

Suggested Reading:

Books:

1. Murphy, Raymond, English Grammar in Use with Answers; Reference and Practice for Intermediate Students, Cambridge: CUP, 2004
2. Jones, Daniel. An English Pronouncing Dictionary, Cambridge: CUP, 2006
3. Brook-Hart,Guy. Cambridge English- Business Benchmark-Upper Intermediate, CUP,2013.
4. Dhanavel, S.P. English and Communication Skills for Students of Science & Engineering, Orient BlackSwan, Chennai: 2016.
5. Swan, Michael.Practical English Usage.4thEdn. OUP. 2017.
6. Elbow, Peter. Writing with Power: Techniques for Mastering the Writing Process. New York, Oxford University Press, 1998.

Extensive Reading:

1. Anthology of Select Five Short Stories
2. Tagore, Rabindranath. *Chitra, a Play in One Act.* London, Macmillan and Co., 1914

Websites:

1. www.englishclub.com
2. owl.english.purdue.edu

3. www.oxfordonlineenglish.com
4.www.bbclearningenglish.com
5. tcesrenglish.blogspot.com

Course Contents and Lecture Schedule

S.No	Topic	No. of Hours
1.	Word Building, Prefix, Suffix and Root Words	1
2.	Parts of Speech	1
3.	Tenses	1
4.	Skimming and Scanning of Short Comprehension Passages	1
5.	Manual Writing	1
6.	Recommendations	1
7.	Note-Making	1
8.	Subject-Verb Agreement	1
9.	Phonemes	1
10.	Syllables and Stress	1
11.	Answering Questions or Cloze exercises based on the text prescribed for extensive reading	1
12.	Noun Compounds, Classifications and Definitions	1
13.	Summary Writing	1
14.	Interpretation of Graphics	1
15.	Cause and Effect, Purpose and Function	1
16.	Jumbled Sentences	1
17.	Formal Letters (Seeking Permission for Industrial Visit/internship/ Bonafide)	1
18.	Phrasal Verbs and Impersonal Passive Voice	1
19.	Numerical Adjectives	1
20.	Framing Questions (WH and Yes/No) and Modals	1
21.	Agenda and Minutes of Meeting	1
22.	Relative Clause	1
23.	E-mail Writing (BEC Vantage Writing Task I)	1
24.	Paragraph Writing	1
	Total	**24**

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22ES150	ENGINEERING EXPLORATION

Category	L	T	P	Credit
ESC	1	1	-	2

Preamble

The course Engineering Exploration provides an introduction to the engineering field. It is designed to help the student to learn about engineering and how it affects our everyday lives. On the successful completion of the course, students will be to explain how engineering is different from science and technology and how science, mathematics and technology are an integral part of engineering design.

Prerequisite

NIL

Course Outcomes

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

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency	Expected Attainment
CO1	Explain technological & engineering development, change and impacts of engineering	TPS2	70	70
CO2	Draw a product in enough detail that others can accurately build it and write specification sheet for a given product	TPS3	70	70
CO3	Complete initial steps (Define a problem, list criteria and constraints, brainstorm potential solutions and document the ideas) in engineering design process	TPS3	70	70
CO4	Draw sketches to a design problem and provide a trade-off matrix	TPS3	70	70
CO5	Communicate possible solutions through drawings and prepare project report	TPS3	70	70
CO6	Apply the concept of engineering fundamentals in Civil and Mechanical, Engineering	TPS3	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C01	M	L	-	-	-	-	-	-	-	-	-	-
C02	S	M	L	-	-	-	-	-	-	-	-	-
C03	S	M	L	-	-	-	-	-	-	-	-	-
C04	S	M	L	-	-	-	-	-	-	-	-	-
C05	S	M	L	-	-	-	-	-	-	-	-	-
C06	S	M	L	-	-	-	-	-	-	-	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

	Assesment-1						Assesment-2						Terminal Examination		
	Theory						Theory						Theory		
	Worksheet-1			CAT-1			Case study-1			CAT-2					
TPS Scale	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1		30			30									20	
CO2			30			30									15
CO3			40			40									15
CO4								30			30				20
CO5									30			30			15
CO6									40			40			15

Syllabus

What is Engineering: Engineering Requirement, Knowledge within Engineering disciplines, Engineering advancements **Engineering Design:** Problem definition, idea generation through brainstorming and researching, solution creation through evaluating and communicating, text/analysis, final solution and design improvement. **Defining problems and Brainstorming:** Researching design, sketching problem solving. **Communicating solution**: Dimensioning orthographic drawing, perspective drawing. **Modeling and Testing final output:** Product evaluation, reverse engineering, final project report. **Civil Engineering:** Structural forces structural analysis, bridge design components, structural design **Mechanical Engineering:** Types of motion, mechanical power system, mechanical power formula, mechanical design.

Reference Books

1. Ryan A.Brown, Joshua W.Brown and Michael Berkihiser: “Engineering Fundamentals: Design, Principles, and Careers”, Goodheart-Willcox Publisher, Second Edition, 2014.
2. Saeed Moaveni,“Engineering Fundamentals: An Introduction to Engineering”, Cengage learning, Fourth Edition, 2011.

Course Contents and Lecture Schedule

No.	Topic	No. of Periods
1.	**What is Engineering**	
1.1	Engineering Requirement	1
1.2	Knowledge within Engineering disciplines,	1
1.3	Engineering advancements	1
2	**Engineering Design**	
2.1	Problem definition,	1
2.2	idea generation through brainstorming and researching	1
2.3	solution creation through evaluating and communicating,	1
2.4	text/analysis	1
2.5	final solution and design improvement	1
3	**Defining problems and Brainstorming:**	
3.1	Researching design	1
3.2	sketching problem solving	2
4	**Communicating solution**	
4.1	Dimensioning orthographic drawing	1
4.2	perspective drawing	1
5	**Modelingand Testing final output**	
5.1	Product evaluation	1
5.2	reverse engineering	1
5.3	final project report	1
6	**Civil Engineering**	
6.1	Structural forces structural analysis	1
6.2	bridge design components	2

No.	Topic	No. of Periods
6.3	structural design	1
7	**Mechanical Engineering**	
7.1	Types of motion	1
7.2	mechanical power system	1
7.3	mechanical power formula	1
7.4	mechanical design	1
	Total	24

Course Designers:

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22ME160	ENGINEERING GRAPHICS

Category	L	T	P	Credit
ESC	3	0	2	4

Preamble

Engineering Graphics is referred as language of engineers. An engineer needs to understand the geometry of any object through its orthographic or pictorial projections. The knowledge on engineering graphics is essential in proposing new product designs through drawings and in reading or understanding the existing drawings. This course covers orthographic and pictorial projections, sectional views, development of surfaces and use of computer aided drafting tools.

Prerequisite

Basic knowledge about geometry of objects.

Course Outcomes

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

CO Number	Course Outcomes	TCE Proficiency Scale	Expected Proficiency in %	Expected Attainment Level %
C01	Draw the orthographic views of objects from the given isometric views and draw the orthographic projections of points.	TPS 3	70	70
CO2	Draw the orthographic projections (Elevation and Plan) of straight lines inclined to both reference planes.	TPS 3	70	70
CO3	Draw the orthographic projections (Elevation and Plan) of plane surfaces inclined to both reference planes.	TPS 3	70	70
CO4	Draw the orthographic projections (Elevation and Plan) of regular solids (Prisms, Pyramids, Cylinder and Cone) with axis inclined to any one-reference plane.	TPS 3	70	70
CO5	Draw the orthographic projections (Elevation and Plan) of sectioned solids (Prisms, Pyramids, Cylinder and Cone) and true shape of the sections.	TPS 3	70	70
CO6	Draw the development of surfaces (base and lateral) of sectioned regular solids (Prisms, Pyramids, Cylinder and Cone).	TPS 3	70	70
CO7	Draw the isometric projections of regular solids and combined solids (Prisms, Pyramids, Cylinder, Cone and Sphere) and convert the orthographic projections into isometric views.	TPS 3	70	70
CO8	Create computer-aided 3D models for the given drawing (2D/3D) and draw orthographic views for the 3D model with appropriate dimensioning using CAD package (Continuous Assessment only).	TPS 3	Continuous Assessment only	

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	PSO 3
CO1.	S	M	S	M	M	_	_	_	M	M	_	_	M	_	_
CO2.	S	M	S	M	M	_	_	_	M	M	_	_	M	_	_
CO3.	S	M	S	M	M	_	_	_	M	M	_	_	M	_	_
CO4.	S	M	S	M	M	_	_	_	M	M	_	_	M	_	_
CO5.	S	M	S	M	M	_	_	_	M	M	_	_	M	_	_
CO6.	S	M	S	M	M	_	_	_	M	M	_	_	M	_	_
CO7.	S	M	S	M	M	_	_	_	M	M	_	_	M	_	_
C08.	S	M	S	M	S	_	_	_	M	M	_	_	M	_	_
Over all	3	2	3	2	2.13	0	0	0	2	2	0	0	2	0	0
	S	M	S	M	M	-	-	-	M	M	-	-	M	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category / TPS Scale	Continuous Assessment Test	Terminal Examination
Remember / 1		
Understand / 2		
Apply / 3	100	100
Analyse / 4		
Evaluate / 5		
Create / 6		

Marks Allocation for Continuous Assessment:

Sl. No	Description	Marks
1	Submission of Plates (Drawing sheets) and Computer Aided Drafting (CAD) Exercises	60
2	Continuous Assessment Test (CAT)	40
Total		**100**

Question Pattern for Terminal Examination:

Question Number	Description	Type	Marks
1	Orthographic views from isometric view Or Projection of Points	Either or type	10
2	Projection of lines	Either or type	15
3	Projection of planes	Either or type	15
4	Projection of solids	Either or type	15
5	Section of solids	Either or type	15
6	Development of surfaces	Either or type	15
7	Isometric projections of combined solids Or Conversion of orthographic views into isometric view	Either or type	15
Total			**100**

Note:

1. **One test or two tests will be conducted locally by respective Faculty In - charges during regular class hours to account for continuous assessmenttest (CAT) marks.**

2. **Terminal examination (3 hrs) will be conducted centrally by the office of Controller of examinations.**

Syllabus

Introduction- Significance of engineering graphics, Use of drawing instruments, Standards, Lettering and dimensioning, Scales.

Orthographic Projection - Principles of orthographic projections, First angle projection, Orthographic projection of objects from pictorial views. Projection (Elevation and Plan) of points located in all quadrants.

Projection (Elevation and Plan) of straight lines in first quadrant, inclined to both reference planes by rotating line method.

Projection (Elevation and Plan) of plane surfaces in first quadrant, inclined to both reference planes by rotating object method.

Projection (Elevation and Plan) of regular solids (Prisms, Pyramids, Cylinder and cone) in first quadrant, by rotating object method when the axis is inclined to one of the reference planes.

Projection (Elevation and Plan) of sectioned solids (Prisms, Pyramids, Cylinder and cone) and true shape of the sections, when the axis of the solid is perpendicular to horizontal plane.

Development of base and lateral surfaces of sectioned regular solids (Prisms, Pyramids, Cylinder and Cone) with cutting plane inclined to HP only.

Isometric projection – Principle, isometric scale, Isometric views and Isometric projections of single simple solids. Combination of solids (Prisms, Pyramids, Cylinder, Cone and sphere -in simple vertical positions only). Conversion of orthographic projections (Elevation, Plan and Side view) of solid parts / engineering components into isometric views.

Computer Aided Drafting (For Continuous Assessment only):

Overview of Computer Graphics, list of computer technologies, impact on graphical communication. Demonstrating knowledge of the theory of CAD software such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), Command Line, Status Bar, Different methods of zoom as used in CAD, Select and erase objects. Setting up of units and drawing limits. Dimensioning – Guidelines – ISO and ANSI standards for coordinate dimensioning - Defining local coordinate systems. Orthographic and isometric views.

Practice on drawing of 2 dimensional geometric patterns consisting of entities such as lines, arcs and circles. Practice on creation of 3 dimensional wire-frame and shaded models. Dimensioning in isometric and orthographic views.

Text Book

1. Bhatt N.D., Panchal V.M. and Ingle P.R., (2014) “Engineering Drawing”, Charotar Publishing House.

Reference Books

1. Natarajan K.V., “A text book of Engineering Graphics”, DhanalakshmiPublishers, Chennai, 2012.
2. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2019.
3. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 2011.
4. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Publications, Bangalore, 2017.
5. Shah M.B, and Rana B.C (2009) “Engineering Drawing and Computer Graphics”, Pearson Education.
6. CAD Software Theory and User Manuals.

Course Contents and Lecture Schedule

Sl.No	Topic	Lecture Hours	Practice Hours
1	**Introduction**- Significance of engineering graphics, Use of drawing instruments **–**Standards, Lettering and dimensioning, Scales	2	1
2	**Orthographic Projection-**Principles of orthographic projections, First angle projection, **Orthographic projection of objects from pictorial views.**	2	2
3	**Projection (Elevation and Plan) of points** located in all quadrants.	2	1
4	**Projection (Elevation and Plan) of straight lines** in first quadrant, inclined to both reference planes by rotating line method.	4	2
5	**Projection (Elevation and Plan) of plane surfaces** in first quadrant, inclined to both reference planes by rotating object method.	5	3
6	**Projection (Elevation and Plan) of regular solids**(Prisms, Pyramids, Cylinder and cone)in first quadrant, by rotating object method when the axis is inclined to one of the reference planes.	5	3
7	**Projection (Elevation and Plan) of sectioned solids**(Prisms, Pyramids, Cylinder and cone) and true shape of the sections, when the axis of the solid is perpendicular to horizontal plane.	4	2
8	**Development of surfaces**(base and lateral) **of sectioned regular solids** (Prisms, Pyramids, Cylinder and Cone)with cutting plane inclined to HP only.	4	2
9	**Isometric projection –** Principle, isometric scale, Isometric views and Isometric projections of single simple solids. Combined solids (Prisms, Pyramids, Cylinder, Cone and sphere -in simple vertical positions only). **Conversion of orthographic projections** (Elevation, Plan and Side view) of solid parts / engineering components into isometric views.	4	2

10	**Computer Aided Drafting** (For Continuous Assessment only)**:** **10.1** Overview of Computer Graphics, list of computer technologies, impact on graphical communication. Demonstrating knowledge of the theory of CAD software such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line, The Status Bar, Different methods of zoom as used in CAD, Select and erase objects. Setting up of units and drawing limits. Dimensioning – Guidelines – ISO and ANSI standards for coordinate dimensioning - Defining local coordinate systems. Orthographic and isometric views.	1	1
	10.2– Practice on drawing of 2 dimensional geometric patterns consisting of entities such as lines, arcs and circles. Practice on creation of 3 dimensional wire-frame and shaded models. Dimensioning in isometric and orthographic views.	3	5
	TOTAL	**36**	**24**

Course Designers:

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22EG170	ENGLISH LABORATORY

Category	L	T	P	Credit
HSMC	0	0	2	1

Preamble

This practical course enables the students to develop and evaluate their basic English language skills through individualized learning process at the Language Lab, using English Software and online resources. In addition, it facilitates students with the need-based student-centric presentation sessions in a multi-media driven classroom environment.

Prerequisite

- NIL

Course Outcomes

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

COs	Course Outcomes	TCE Proficiency Scale
CO1	Interpret words correctly through listening and watching general and technical online contents	Understand
CO2	Develop appropriate pronunciation skills through listening and speaking practices	Apply
CO3	Build and apply a wide range of lexicons in general and technical presentations	Apply
CO4	Identify and apply the key ideas and spoken English features learnt through auditory and visual listening tools	Apply
CO5	Experiment with inventiveness by creating a blog, vlog, or YouTube channel.	Apply
CO6	Prepare and deliver oral and written presentations using digital tools.	Apply

Mapping with Programme Outcomes

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

Assessment Pattern

- Students' performance will be assessed in the language lab/ classroom as given below:
  - Spoken Task - General / Technical Presentation / Picture Description: 20 Marks
  - Listening Task –(MCQs, Gap Filling Exercises) : 10 Marks
  - Written Test - Phonetics, Grammar, Vocabulary, Reading : 20 Marks

External: Online Exam- Phonetics, Grammar, Vocabulary, Reading (45 Minutes): 50 Marks
Listening Test : 20 Marks
Submission of Students' Record on Practical Tasks in the Class and Lab :10 Marks
BEC Vantage Speaking Tasks I and II : 20 Marks

List of Experiments

S.No	Topic	Hours
	LAB ACTIVITIES (12 Hours)	
1	Listening to TED Talks/ Podcasts/ Product Advertisements/ News Bulletins.	2
2	Phonetics – Tutorials through Online Repositories, English Movie Clips and Software in the Lab(S-net)	2
3	Vocabulary Development through Movies / Short Films/ Documentaries	2
4	Language Development through English software S-net and Online Content (Tenses, Voices, SV Agreement, Prepositions, Coherence Markers, Relative Clauses, Modals, Punctuation)	2
5	Reading Comprehension – I (General / Technical, BEC Vantage Reading Task III)	2
6	Creating a Blog/Vlog/YouTube Channel –Uploading MP3/MP4 – Practice (Movie/Book/ Gadget Review, General/Tech Talks, Interview with Celebrities)	1
7	Revision – Model Online Aptitude Test	1
	CLASSROOM ACTIVITIES (12 Hours)	
8	Introduction of Spoken English Features	1
9	Self-introduction and Introducing others	1
10	Video Comprehension – Brainstorming and Note-Taking	2
11	Role-Play, Picture/Movie Description	1
12	Reporting the events from Media / Newspapers – Discussion	1
13	Interactive Games for Language Development	1
14	Reading / Note Making (Extensive Reading – News Paper Reports)	1
15	Presentation – I (Book /Movie Review, Story Telling, General Presentations)	2
16	Presentation – II (Technical Presentations)	2
	Total	24

Software Used:

1. English Software S Net
2. Business English Certificate-Vantage- Practice Software

Teaching Resources and Websites:

1. Open Online Repositories from Oxford / Cambridge / British Council/ Voice of America
2. Free Video Downloads from YouTube
3. www.ted.com
4. tcesrenglish.blogspot.com

Course Designers:

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22PH180	PHYSICS LABORATORY

Category	L	T	P	Credit
BSC	0	0	2	1

Preamble

This course ensures that students are able to apply the basic physics concepts and carry out the experiments to determine the various physical parameters related to the material

• Learn the necessary theory to understand the concept involved in the experiment.
• Acquire the skills to carry out the experiment.
• Tabulate the observed data and use the formula to evaluate the required quantities.
• Plot the data in a graph and use it for calculation.

Prerequisite

- None

Course Outcomes

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

Cos	Course Outcome	TCE Proficiency Scale	Expected Proficiency (%)	Expected Attainment Level (%)
CO1	Analyze the mechanical & electrical oscillations and determine their resonance frequency	TPS3	85	90
CO2	Analyse the interference and diffraction patterns for micron sized objects	TPS3	85	90
CO3	Investigate the V-I characteristics of photodiode, phototransistor under dark and bright illumination conditions	TPS3	85	90
CO4	Determine the Planck's constant using LEDs	TPS3	85	90
CO5	Plot the VI characteristics of solar cell and find the fill factor	TPS3	85	90
CO6	Determine the reversibility of classical and quantum logic gates	TPS3	85	90
CO7	Identify the variation of magnetic field with distance for circular coils	TPS3	85	90

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

LIST OF EXPERIMENTS

1. Quantum Logic Gate-Toffoli gate
2. Study of Optoelectronic Devices- Photodiode, Phototransistor.
3. Solar cell VI characteristics, fill factor & Optical fibre -Determination of numerical aperture.
4. Torsional pendulum – Determination of rigidity modulus of wire and moment of inertia of regular objects.
5. Laser Diffraction - Determination of wave length of the laser using grating and determination of micro particle size.(Observing diffraction pattern due to single and double slit)
6. Air wedge – Determination of thickness of a thin sheet/wire.
7. Determination of Planck's constant through V-I characteristics of LED.
8. Determination of magnetic field-Stewart and Gees.
9. LCR Circuit – Determination of resonant frequency

Course Designer(s):

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22CH190	CHEMISTRY LABORATORY (COMMON TO ALL BRANCHES)

Category	L	T	P	Credit
BSC	0	0	2	1

Preamble

This course aims to provide the students, a basic practical knowledge in chemistry. The objective of this course is to develop intellectual and psychomotor skills of the students by providing hands on experience in quantitative, electrochemical and photo-chemical analysis.

Prerequisite

Nil

Course Outcomes

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

CO	Course Outcome	TCE Proficiency Scale
CO1	Estimate the chemical water quality parameters of sample water / effluent	TPS Apply
CO2	Demonstrate presence of calcium ions in milk sample	TPS Apply
CO3	Determine the surface tension of solvent mixtures	TPS Apply
CO4	Estimate pH and acid content of samples using pH metric and conductometric titrations	TPS Apply
CO5	Illustrate the strength of oxidisable materials present in given sample by potentiometric method	TPS Apply
CO6	Determine Fe^{2+} ion in effluent using colorimetric method	TPS Apply
CO7	Calculate the efficiency of electroplating	TPS Apply
CO8	Determine the rate of corrosion of metal & alloy using potentio-dynamic polarisation method	TPS Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	S	M	L	-	M	-	-	-	L	-	-	-
CO2.	S	M	L	-	M	-	-	-	L	-	-	-
CO3.	S	M	L	-	M	-	-	-	L	-	-	-
CO4.	S	M	L	-	M	-	-	-	L	-	-	-
CO5.	S	M	L	-	M	-	-	-	L	-	-	-
CO6.	S	M	L	-	M	-	-	-	L	-	-	-
CO7.	S	M	L	-	M	-	-	-	L	-	-	-
CO8.	S	M	L	-	M	-	-	-	L	-	-	-

S- Strong; M-Medium; L-Low

List of Experiments/Activities with CO Mapping

Experimental List	CO
Quantitative Analysis	
Estimation of total hardness of water sample	CO1
Estimation of COD of industrial effluent	CO1
Determination of calciumion inmilk sample	CO2

Determination of surface tension of solvent mixture	CO3
Electrochemical and Photochemical Analysis	
Determination of the Phosphoric acid content in soft drinks using conductometric titration	CO4
Determination of pH of soil by pH metric titration	CO4
Potentiometric redox titration ($K_2Cr_2O_7$vs FAS, $KMnO_4$vs FAS)	CO5
Estimation of iron content in water sample using colorimeter	CO6
Estimation of current density of electroplating process using Hull cell	CO7
Determination of rate of corrosion of metal and alloy using potentiodynamic polarization technique (TAFEL)	CO8

Learning Resources

1. Vogel's Textbook of Quantitative Chemical Analysis (8^{TH}edition, 2014)
2. Laboratory Manual – Department of Chemistry, Thiagarajar College of Engineering (2022)

Course Designers:

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22CE210	MATRICES AND ORDINARY DIFFERENTIAL EQUATIONS

Category	L	T	P	C
BSC	3	1	-	4

Preamble

Matrix eigen value problems are extremely important while creating engineering models in designing bridges, communication systems and searching algorithms. This course introduces the concepts and applications of matrix eigen values, differentiation and integration of vector valued functions and ordinary differential equations in a broader approach to Civil engineers. Moreover, numerical techniques are effectively used to solve ordinary differential equations. This course provides the knowledge of the above concepts to all Engineers and apply them in their areas of specialization.

Prerequisite

22MA110 – Calculus for Engineers

Course Outcomes

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

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Understand the concept of rank of a matrix to check the consistency of a system.	TPS3	A	65
CO2	Diagonalize the matrix using eigen values and eigen vectors by means of transformations	TPS2	A	65
CO3	Compute the gradient, divergence and curl of scalar and vector functions.	TPS3	A	65
CO4	Apply the concepts of vector calculus to evaluate forces and moments.	TPS3	A	65
CO5	Solve the homogeneous and non-homogeneous differential equations using appropriate methods.	TPS3	A	65
CO6	Apply numerical techniques to solve ordinary differential equations.	TPS3	A	65

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Assessment	CAT 1			CAT 2			Terminal exam			Assignment 1			Assignment 2		
TPS / COs	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	3	9	-	-	-	-	-	6	-	-	10	-	-	-	-
CO2	3	9	26	-	-	-	-	-	18	-	-	40	-	-	-
CO3	3	15	-	-	-	-	-	6	-	-	10	-	-	-	-
CO4	-	-	32	-	-	-	-	-	16	-	-	40	-	-	-
CO5	-	-	-	6	17	27	-	12	15	-	-	-	-	10	40
CO6	-	-	-	6	17	27	-	12	15	-	-	-	-	10	40

Syllabus

SYSTEM OF LINEAR EQUATIONS AND EIGEN VALUE PROBLEMS: Rank of a matrix - Consistency and Inconsistency of system linear of equations -Vectors - Eigen values and Eigen vectors - Properties of eigen values-Matrix of a Linear transformation - Reduction to diagonal form- Cayley-Hamilton theorem- Quadratic forms- Reduction to canonical form - Nature of quadratic forms. **VECTOR CALCULUS:** Gradient, Divergence, Curl of a vector Field- Line Integrals of vector functions –Path independence of line integrals- Green's Theorem in the plane- Surface Integrals-Triple Integrals, Stoke's and Divergence Theorem of Gauss-Applications of the Divergence theorem. **SECOND ORDER HOMOGENEOUS ORDINARY DIFFERENTIAL EQUATIONS(ODEs):** Homogeneous Linear ODEs of second order with constant coefficients– The Differential Operator- Euler Cauchy's Equations– Modelling of free oscillation of a mass spring system- Existence and uniqueness of solution by Wronskian-Non-homogeneous Linear ODE of second order – Solution by Variation of Parameters. **NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS:** Single Step methods: Picard's method of successive Differentiation- Euler's method, Improved &Modified Euler's method –. Multi-step methods: Runge-Kutta method of fourth order - Milne's and Adams Bash-forth Predictor-corrector methods.

Reference Books

1. Erwin Kreyszig, "Advanced Engineering Mathematics",10th edition, Wiley. New Delhi,2017.
2. B.S. Grewal, "Higher Engineering Mathematics",42nd Edition, Khanna Publishers, New Delhi 2012.
3. PeterO'Neil,"AdvancedEngineeringMathematics,7th Edition, Cengage Learning,2017.
4. Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, New Delhi, 2016.

Course Contents and Lecture Schedule

No.	Topic	No. of Periods
1.	**SYSTEM OF EQUATIONS AND EIGEN VALUE PROBLEMS**	
1.1	Rank of a matrix – Consistency of Linear system of equations.	2
	Tutorial	1
1.2	Eigen values and eigen vectors, Properties of eigen values.	2
1.3	Linear transformations and Reduction to diagonal form.	1
1.4	Cayley-Hamilton theorem	2
	Tutorial	1
1.5	Reduction of quadratic form to canonical form	1
1.6	Nature of quadratic forms	1
	Tutorial	1
2.	**VECTOR CALCULUS**	
2.1	Gradient of a scalar filed	2
2.2	Divergence and Curl of a Vector Field	1
	Tutorial	1
2.3	Line Integrals	2

No.	Topic	No. of Periods
2.4	Green's Theorem in the Plane	1
	Tutorial	1
2.5	Surface Integrals	1
2.6	Stoke's Theorem	1
2.7	Triple Integrals and Divergence theorem of Gauss	1
	Tutorial	1
3.	**SECOND ORDER ORDINARY DIFFERENTIAL EQUATIONS**	
3.1	Homogeneous Linear ODEs of Second Order	2
3.2	Homogeneous Linear ODEs with Constant Coefficients	1
	Tutorial	1
3.3	Differential Operators	1
3.4	Modeling of Free Oscillations of a Mass–Spring System	2
	Tutorial	1
3.5	Non homogeneous ODEs	2
3.6	Solution by Variation of Parameters	1
	Tutorial	1
4	**NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**	
4.1	Single Step methods- Picard's method of successive Differentiation	1
4.2	Euler's method, Improved & modified Euler's method	2
	Tutorial	1
4.3	Runge - Kutta method of fourth order	2
4.4	Milne's Predictor corrector method	2
	Tutorial	1
4.5	Adams-Bashforth predictor corrector method	2
	Tutorial	1
	Total	**48**

Course Designers:

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22CE220	ENGINEERING MECHANICS

Category	L	T	P	Credit
ESC	3	1	0	4

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. 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

Basic Concepts of Physics and Mathematics

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Solve practical problems through evaluating the laws of mechanics and also to apply equilibrium concepts	TPS3	A	70
CO2	Compute geometric properties of sections	TPS3	A	70
CO3	Understand and apply the concept of stress and strain to solve structural mechanics problem also transformation of stress	TPS3	A	65
CO4	Practice shear force and bending moment computations and construct shear force and bending moment diagrams	TPS3	A	65
CO5	Interpretation of bending and shear stresses for various sections	TPS3	A	65
CO6	Understand and apply the criterion of failure and for design according to various theories.	TPS3	A	65

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	6	13	20	-	-	-	-	-	-	-	-	-	2	5	10	-	-	-	-	-	30		-	-	-	-	-	-	-	-
CO2	6		16	-	-	-	-	-	-	-	-	-	2	-	10	-	-	-	-	-	30		-	-	-	-	-	-	-	-
CO3	6	13	20	-	-	-	-	-	-	-	-	-	2	-	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	6	13	20	-	-	-	2	-	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO5	-	-	-	-	-	-	6	-	16	-	-	-	2	-	15	-	-	-	-	-	-	-	-	-	-		30	-	-	-
CO6	-	-	-	-	-	-	6	13	20	-	-	-	-	5	15	-	-	-	-	-	-	-	-	-	-		30	-	-	-

Syllabus

Statics of Particles and Rigid Bodies; Laws of Mechanics - Lame's theorem, Parallelogram and triangular law of forces - Coplanar forces - Resolution and composition of forces - Equilibrium of a particle - Principle of transmissibility. Types of supports and reactions - Requirements of stable equilibrium - Moments and couples - Varignon's theorem - Equilibrium of rigid bodies. **Properties of surfaces:** First moment of area and centroid of sections - Second Moment of area - Moment of Inertia - Parallel Axis Theorem - Perpendicular axis theorem - Polar Moment of Inertia - Radius of Gyration - Principal moments of inertia**.** Spread sheets**-** Algorithm for developing spread sheet for calculating moment of inertia for composite section. **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. Thermal stress and strain. **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). Spread sheets**-** Algorithm for constructing SFD and BMD for statically determinate beam. **Bending and shear stresses:** bending stresses, shear stresses in various sections. **Theories of Failure:** Maximum principal stress theory-Maximum shear stress theory-shear strain energy theory.

Text Book

1. R.K.Rajput- Strength of Materials, 4th edition, S,Chand& company limited, New Delhi, 2007.

Reference Books& web resources

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. https://nptel.ac.in/courses/105105108/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1.0	**Statics of Particles and Rigid Bodies**	
1.1	Laws of Mechanics - Lame's theorem, Parallelogram and triangular law of forces.	1
1.2	Coplanar forces - Resolution and composition of forces - Equilibrium of a particle - Principle of transmissibility	1
1.3	Types of supports and reactions - Requirements of stable equilibrium - Moments and couples - Varignon's theorem - Equilibrium of rigid bodies	2
	Tutorial	1
2.0	**Properties of surfaces**	
2.1	First moment of area and centroid of sections - Second Moment of area - Moment of Inertia	1
2.2	Parallel Axis Theorem - Perpendicular axis theorem - Polar Moment of Inertia - Radius of Gyration - Principal moments of inertia	1
	Tutorial	1
	Spread sheets**-** Algorithm for developing spread sheet for calculating moment of inertia for composite section	2
3.0	**Simple stresses and strains**	
3.1	Introduction to stress and strain, tensile, compressive and shear stress and strain .	1
3.2	Hooke’s law ,Young’s Modulus, Rigidity Modulus, Bulk Modulus, Poisson’s Ratio .	2
3.3	Relationship between elastic constants , Stress-strain diagram for mild-steel, Elastic Limit	2
	Tutorial	1
	Principal stresses and strains	
3.4	Plane Stress and Plane Strain, Analytical method	2
3.5	Principal stresses and strains, Mohr’s circle method	2
	Tutorial	1
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	2
4.2	Shear Force and Bending Moment diagram for cantilever beams	1
4.3	Shear Force and Bending Moment diagram for simply supported beams.	2

Module No.	Topic	No. of Periods
4.4	Shear Force and Bending Moment diagram for overhanging beams.	2
	Tutorial	2
	Spread sheets- Algorithm for constructing SFD and BMD for statically determinate beam	2
5.0	**Bending and shear stresses**	
5.1	Bending stresses in various sections - (Rectangular, circular, flanged, angle, and channel cross-sections	2
	Tutorial	2
5.2	Shear stress in various sections – (Rectangular, circular, flanged, angle, and channel cross-sections)	2
	Tutorial	2
6.0	**Theories of Failure**	
6.1	Maximum Principal Stress Theory	2
6.2	Maximum Shear Stress Theory	2
6.3	Shear Strain Energy Theory	2
	Tutorial	2
	Total (36+12)	48

Course Designer(s):

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22CE230	SURVEYING

Category	L	T	P	Credit
PCC	3	0	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 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.

Prerequisite

Nil

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Compute the linear measurements using chains, angular measurements using compass and omitted measurement	TPS 3	A	70
CO2	Understand the principles of plane table surveying & traverse.	TPS 3	A	70
CO3	Find the relative position of points on the ground using leveling principles, contouring- methods computation of areas and volume	TPS 3	A	65
CO4	Calculate the distance and heights of objects using tacheometric and trigonometric principle	TPS 3	A	65
CO5	Compute the elements of different types of curves and triangulation systems	TPS 3	A	65
CO6	Understand the principle of Total station and GPS	TPS 3	A	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	5	25	-	-	-	-	-	-	-	-	-	5	5	10	-	-	-	-	-	30		-	-	-	-	-	-	-	-
CO2	5	5	10	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	20		-	-	-	-	-	-	-	-
CO3	5	5	35	-	-	-	-	-	-	-	-	-	-	5	15	-	-	-	-	-	50		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	10	10	30	-	-	-	5	5	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO5	-	-	-	-	-	-	5	5	20	-	-	-	-	5	10	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO6	-	-	-	-	-	-	5	5	10	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-		20	-	-	-

Syllabus

Introduction: Definition, classification of surveys, **Chain surveying:** Ranging and Chaining, obstacles in chaining. **Compass surveying:** Prismatic compass, Magnetic declination, local attraction. **Plane table surveying:** Accessories, 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 **Tacheometric Survey:** Measurement of horizontal and vertical angle, Stadia, tangential and Trigonometrical levelling **Curves:** setting out of simple and compound curves. **Triangulation:** Types of triangulations, systems, figures, signals and baseline measurement. **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, 17th Edition, New Delhi, 2016.

Reference Books& web resources

1. Kanetkar,T.P, and Kulkarni, S.V,"Surveying and Levelling" Vol.I&II, Pune VidyarthiGrihaPrakashan, 24th Revised Edition, Pune,2010.
2. Venkatramaiah C, "Textbook of Surveying", University Press, 2nd Edition, Hyderabad, 2011.
3. https://nptel.ac.in/courses/105104101/1

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours
1	**Chain, Compass Surveying**	
1.1	Classification of Survey, ranging, chaining and obstacles in chaining	1
1.2	Measurement of bearings and angles using compass, Local attraction and magnetic declination	1
1.3	Calculation of included angle	1
1.4	Local attraction	1
1.5	Omitted measurements	1
2	**Plane table surveying:**	
2.1	Accessories of plane table and their uses, plane table techniques	1
2.2	Radiation and intersection method	
2.3	Method of resection – Three-point problem	
2.4	Three point problem – Trial and error method, tracing paper	1

2.5	Three point problem – Bessel's method	1
2.6	Three point problem -Right angle method	
2.7	Method of resection – Two point problem	1
2.8	Traversing by using plane table	
3	**Levelling**	
3.1	Types of levels and its adjustments	1
3.1	Reciprocal levelling, Fly levelling, Check levelling	2
3.1	Longitudinal and Cross sectioning levelling	1
3.1	Uses and Characteristics and methods of Contour	1
3.1	Methods of contouring	1
3.1	Calculation of areas and volumes by mid-ordinate, average ordinate, trapezoidal and Simpson's methods	2
4	**Tacheometric Survey**	
4.1	Theodolite parts, adjustments and constants	1
4.2	Consecutive coordinates, independent coordinates	
4.3	Omitted Measurements	2
4.4	System of Tacheometry – stadia and tangential	1
4.5	Measurement of horizontal, vertical angle and distance by stadia principle.	
4.6	Measurement of horizontal, vertical angle and distance by tangential principle.	1
4.7	Trigonometrical levelling -Single plane	1
4.8	Trigonometrical levelling -double plane	1
5	**Curves**	
5.1	Types of circular curves	1
5.2	Relationship between radius and degree of curve and elements of simple circular curves	
5.3	Linear methods of setting out simple circular curve- offsets from long chord	1
5.4	Linear methods of setting out simple circular curve – Offsets from tangents	
5.5	Linear methods of setting out simple circular curve – Offsets from chords produced	1
5.6	Linear methods of setting out simple circular curve – Offsets from chords produced – successive bisection of arcs	
5.7	Angular methods of setting out simple circular curve- Rankine's method of deflection angles	1
5.8	compound and reverse curves	1
5.9	transition curve – to find the length of transition curve	1
	Triangulation:	
5.10	Types of triangulations, systems, figures, signals	1
5.11	Baseline measurement.	1
6	**Modern Methods of Surveying**	
6.1	Electronic Distance Measurements (EDM),	1
6.2	Applications of Global Positioning System (GPS)	1
6.3	Total Station and its applications	2
6.4	Digital Elevation Model (EDM)	1
	Total Hours	**36**

Course Designers:

1. Dr. K. Sudalaimani ksudaliamani@tce.edu
2. Dr. T. Baskaran tbciv@tce.edu
3.Dr R.Ponnudurai rpdciv@tce.edu

22CE240	PROGRAMMING FOR PROBLEM SOLVING

Category	L	T	P	Credit
ESC	3	0	0	3

Preamble

This course provides students with the opportunity to gain a thorough understanding of how to solve problems in a precise manner and how to design computer solutions. The course emphasizes the use of problem-solving techniques, the design and development of algorithms, and the mastery of computer programming skills.

Prerequisite

- nil

Course Outcomes

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

COs	Course Outcomes (CO)	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Describe the program design and problem-solving aspects used to provide a solution for the given problem and construct flowcharts for modelling the solution.	TPS2	A	70
CO2	Illustrate algorithms for solving engineering problems and simple mathematical problems to examine the suitability of appropriate repetition and/or selection structures for given problems	TPS3	A	65
CO3	Practice program for array processing techniques related to matrix manipulation problems.	TPS3	A	65
CO4	Build programs for function, recursion and string manipulation concepts as applicable.	TPS3	A	65
CO5	Apply algorithms and programs for solving various searching and sorting problems.	TPS3	A	65
CO6	Construct solutions for the storage, retrieval and processing of data using structures and files.	TPS3	A	65

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	Assessment 1 (Theory)								Assessment 2 (Theory)								Terminal (Theory)					
	CAT 1				Assignment 1				CAT 2				Assignment 2									
TPS Scale	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**5**	**6**
CO1	2	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	10	-	-	-	-
CO2	6	15	15	-	-	-	50	-	-	-	-	-	-	-	-	-	-	10	15	-	-	-
CO3	2	-	30	-	-	-	50	-	-	-	-	-	-	-	-	-	2	-	15	-	-	-
CO4	-	-	-	-	-	-	-	-	4	15	20	-	-	-	50	-	2	-	15	-	-	-
CO5	-	-	-	-	-	-	-	-	4	15	20	-	-	-	50	-	2	-	15	-	-	-
CO6	-	-	-	-	-	-	-	-	2	-	20	-	-	-	-	-	2	10	-	-	-	-

*Terminal examination should cover all Course Outcomes in the appropriate TPS Scale level.

Syllabus

Introduction to Computer Problem Solving – Problem solving aspect –Top-down Design – Implementation of Algorithm – Flowcharts. **Fundamentals of Algorithms** - Exchanging values of variables, counting. **Fundamentals of Programming and Factoring Methods** - Data types, Input and Output Statements, Operators and Expressions, Control structures - Selection Control Structures - Repetition Control Structures - Summation of set of number - Reversing the digits of an Integer, Factoring Methods - Finding square root of a number -The smallest divisor of an integer, Generating Prime numbers. **Array Techniques**–Use of 1D and 2D arrays, Finding the maximum number in a set - Finding K^{th} smallest number, Partitioning an array. Matrix manipulations – Addition, Multiplication. **Functions and Recursion** - Function Declaration, definition and execution, Factorial computation, Fibonacci sequence generation, String Manipulations – comparison between strings, copying of strings, searching for substring. **Sorting and Searching Algorithms** – Bubble sort, Selection sort, Linear Search, Binary search. **Structures and Files**—Structures – Storing and accessing elements, Array of Structures – Files – Read and Write operations on text files.

Text Book

1. R.G Dromey, How to solve it by Computer, Pearson Education, Delhi, 2008

Reference Books & web resources

1. Lesley Anne Robertson Simple Program Design, A Step-by-Step Approach, 5th Edition, Thomson, 2007.
2. YashavantKanetkar , Let Us C, 16th Edition, BPB Publications, 2017.
3. Yashavantkanetkar, Computer System and Programming In C, First Edition, BPB Publications 2018.
4. BalagurusamyE ,Programming In ANSI C , Seventh Edition, Tata Mc-Graw Hill, 2017.
5. Herbert Schildt, C: The Complete Reference, Fourth Edition, Tata Mc-Graw Hill, 2000.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Introduction to Computer Problem Solving (6)**	
1.1	Problem Solving aspect, Top-Down Design	2
1.2	Implementation of an Algorithm, Flow charts	2
1.3	Fundamentals of Algorithms - Exchanging the values of two variables, Counting	2
2	**Fundamentals of Programming and Factoring Methods (10)**	
2.1	Data types, Input and Output Statements	2
2.2	Operators and Expressions	2
2.3	Control Structures - Selection Control Structures, Repetition Control Structures	2
2.4	Summation of a set of numbers, Reversing the digits of an Integer.	1
2.5	Factoring Methods - Finding square root of a number - The smallest divisor of an integer	2
2.6	Generating Prime numbers	1
3	**Array Techniques (5)**	
3.1	Use of 1D and 2D arrays	2
3.2	Finding maximum and the minimum value in a set	1
3.3	Finding K^{th} smallest number, Partitioning an array	1
3.4	Matrix manipulations – Addition and Multiplication	1
4	**Functions and recursion (6)**	
4.1	Function Declaration, definition and execution	2
4.2	Factorial Computation	1
4.3	Fibonacci sequence generation	1
4.4	String manipulations – Comparison between strings, Copying of strings, Searching for substring	2
5	**Sorting and Searching Algorithms (4)**	
5.1	Bubble Sort, Selection sort	2
5.2	Linear Search, Binary Search	2
6	**Structures and Files (5)**	
6.1	Structures- storing and accessing elements	2
6.2	Array of structures	1
6.3	Files – Read and Write operations on text files	2
	Total	**36**

Course Designer(s):

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2. Mrs.P.VijayaPraba Assistant Professor, IT Department pvpit@tce.edu

22CE250	BUILDING MATERIALS AND TECHNOLOGY

Category	L	T	P	Credit
PCC	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 with ventilation as per NBC provisions. This course also aims to apply the theoretical knowledge to practical problems.

Prerequisite

Nil

Course Outcomes

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

COs	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Apply NBC provisions and plan components of residential buildings for the given plot sizes asper NBC along with ventilation aspects	TPS3	A	70
CO2	Explain the properties and uses of various natural building materials, conduct tests on materials such as stone, aggregates, lime, timber for an given applications	TPS3	A	65
CO3	Explain the properties and uses of various man made building materials, conduct tests on materials such as bricks, steel, cement and select suitable material for an given applications	TPS3	A	65
CO4	Explain the components of building in sub–structure and superstructure. Also identify, describe and demonstrate the techniques used for their construction	TPS3	A	65
CO5	Identify and describe the salient features and uses of various flat and pitched roofs, weathering course, Floor, flooring pointing, plastering, painting including scaffolding, shoring and underpinning	TPS3	A	65
CO6	Select appropriate tools and equipment for testing of materials such as: bricks, cement and steel rods and construction	TPS3	A	70

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S-Strong; M-Medium; L-Low

Assessment Pattern

	Continuous Assessment							Terminal Examination			
	Theory part						Practical part	Theory part			Practical part
	CAT-I			CAT-II							
TPS Scale / CO	1	2	3	1	2	3		1	2	3	
CO1	6	10	40	-	-	-	Experimentation Observation Record Model Test (100)	2	5	15	100
CO2	2	10	10	-	-	-		2	10	-	
CO3	2	10	10	-	-	-		2	-	15	
CO4	-	-	-	4	8	30		2	5	15	
CO5	-	-	-	4	8	30		2	5	15	
CO6	-	-	-	2	4	10		-	5	-	
Total	10	30	60	10	20	70		10	30	60	

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. Plan suitably a residential building of 300sq.m with kitchen, bedroom, living room and bath & water closet to derive max benefit from natural agencies.
2. A hall in a residential building is having dimension of 6m x 5m. Provide suitableopeningstocatertotheventilationrequirementsfortheroomaspercodalp rovisions.

Course Outcome 2 (CO2)

1. As a civil engineer what parameters you will consider for recommending stone as a building material
2. As a civil engineer identify the criteria for a timber as a good natural building material.

Course Outcome 3 (CO3)

1. As a civil engineer what parameters you will consider for recommending brick as a building material
2. Assume you are a site engineer identify measures for protecting cement

Course Outcome 4 (CO4)

1. Draw the cross section through a wall in a building. Identify the various components at different level, mentioning its functions
2. Identify asuitabletypeofbondinbrickmasonryforthefollowingcasesmentioningitsfeatur es:

i) Partition wall ii) Load bearing wall for 3 storey building

3. Identifyasuitabletypeofstonemasonryforthefollowingcasesmentioningitsfeatu res:

i) Basement wall ii) Superstructure wall

Course Outcome 5 (CO5)

1. Identify a suitable type of floor for the following cases mentioning its features:

i) Flooring in Industrial workshop ii) IT building

2. Vertical expansion is required in a multi-storey building. Identify suitable supporting system required for construction activities without affecting the free space surrounding the building

3. A wide opening is to be made in a solid load bearing wall. Identify a suitable technology for executing it, without affecting the safety of the structure.

Course Outcome 6 (CO6)

1. Identify suitable equipment to be used for the following situations:
   i) Concreting with minimum voids   ii)to maintain verticality in masonry
2. Match suitable equipment with the given applications:

Name of tool/equipment	Application
Spirit level	Mass Concreting
Bulldozer	Proportioning of ingredients in concreting
Needle vibrator	Maintaining horizontality in walls
Mason's square	Maintaining verticality in walls
Batching plant	Compacting concrete in beams
	Compacting concrete in slabs
	Levelling of ground
	Earthwork excavation
	To maintain perpendicularity between walls at corner

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 ventilation aspects in buildings. NBC provisions for fire safety in buildings. **Materials for Construction**: Natural materials - stones, aggregates, timber, lime. Man- made materials: bricks, cement, steel, concrete, plastics, fly ash, GGBS, Silica fume, PCC and RCC, Composite materials – types and applications. **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, straightedge, mortar pans, sieves, trolley, vibrators, bulldozers, draglines, cableways, belt conveyors. **Machinery:** batching plants, transit mixer sand vibratory trucks for ready mixed concrete, pumps, air compressors, hoists and cranes, Choice of construction equipments for different types of works.

TEXT BOOK

1. PunmiaB.C.,AshokKumarJain,ArunKumarJain,―BuildingConstruction‖,Laxmi PublicationsPvt.Ltd.,201

REFERNCE BOOKS

1. RangwalaS.C.,―EngineeringMaterials‖CharotarPublishingHouse,Anand,Indi a,2014
2. DeodharS.V.,― Construction Equipment and Job Planning‖,KhannaPublishers,NewDelhi,2014
3. SurendraSingh,―BuildingMaterials‖,VikasPublishingCompany,NewDelhi,1996
4. BindraandArora,―BuildingMaterialsandConstruction‖,DhanpatRai&Sons,Ne wDelhi,1998
5. National Building Code of India, Bureau ofIndianStandards,2016
6. Peurifoy.R.L,―ConstructionPlanning,EquipmentandMethods‖,McGrawHillCo. ,New York,2010

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.0	**Orientation**		
1.1	Orientation and Classification of Buildings as per NBC	2	CO1
1.2	Site selection and its influencing factor	1	
1.3	National Building Codal provisions for components of residential buildings: Open spaces, Living room, Bedroom, Kitchen, Bathroom and Water closet	2	
1.4	Building Ventilation aspects	1	
2.0	**Materials for Construction**		
2.1	Natural materials - Stones, timber, lime, aggregates– Properties and uses	2	CO2, CO3
2.2	Man made materials- Bricks, cement, concrete, steel, plastics, fly ash, GGBS, silica fume, PCC and RCC, Composite materials -types and applications	2	
3.0	**Components of building & Technologies for Construction**		
3.1	a) Components of Building	1	CO4
	b) Stone Masonry	1	
3.2	Brick Masonry	2	
3.3	Dampproof course	1	
3.4	Lintel and Arches	1	
3.5	Flooring	1	CO4,CO5
3.6	Roofing	1	
3.7	Stairs	2	
3.8	Scaffolding	1	CO5
3.9	Pointing, Plastering and Painting	1	
3.10	Shoring and Underpinning	1	

4.0	**Construction Tools and Machinery**		
4.1	Tools: plumb bob, spirit level, level tube, rammer, spade, shovels, straight edge, mortar pans, sieves, trolley	1	CO6
4.2	Machinery: batching plants, transit mixers and vibratory Trucks for ready mixed concrete, hoists and cranes		
	Total No. of Lecture Hours	**24**	

List of Experiments for Practical Hours

S. No	Description	No. of Hours	Course Outcome
1.	Apply NBC provisions and plan components of residential buildings for the given plot size	4	CO1
2.	Demonstrate the Appropriate tools and equipments used for testing materials such as Bricks, steel and cement	2	CO2, CO6
3.	Tests on bricks (Field test, Compression and water absorption test)	2	CO3
4.	Demonstrate different types bonds in brick masonry work– Stretcher bond, header bond and English bond	2	CO3
5.	Demonstratedifferenttypesbondsinbrickmasonrywork– Flemishbondandzigzagbond	2	CO3
6.	Test on steel (Diameter and tensile strength)	2	CO3
7.	Test on cement (Field test, Consistency and initial setting time)	2	CO3
8.	Identify and classify the different types of stone masonry in the campus	2	CO4
9.	a) Identify and classify the different types of staircases in the campus	1	CO4
	b) Determine the geometrical parameters of dog legged stair	1	
10	Identify and classify the different types of roofs provided in the campus discussing its features	2	CO5
11	Identify and classify the different types of floors and finishes provided in the campus discussing its features	2	CO5
	Total Hours	**24**	

Course Designers:

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22CE270	WORKSHOP

Category	L	T	P	C
PCC	-	-	2	1

Preamble

The workshop is a hands-on training practice for Mechanical engineering students. It deals with fitting, carpentry, sheet metal, welding, and plumbing-related exercises. The course is designed to train the students to identify and manage the tools, materials, and methods required to execute an engineering project. Students will be introduced to a team working environment where they develop the necessary skills for planning, preparing, and executing an engineering project. To enable the student to familiarize various tools, measuring devices, practices, and different methods of manufacturing processes employed in industry for fabricating components. This course is a response to the growing demand for a broad knowledge base for those who undertake a specialized career in science, especially those who take up a research career.

Prerequisite

- NIL

Course Outcomes

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

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Assemble the pipes and joints for the given plumbing pipeline circuit	TPS3	A+	90
CO2	Prepare different types of joints using fitting operations for the given metal plates	TPS3	A+	90
CO3	Fabricate sheet metal components.	TPS3	A+	90
CO4	Fabricate different types of wooden joints.	TPS3	A+	90
CO5	Perform Lap joint / Butt Joint using an arc welding process	TPS3	A+	90

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	S	M	L	L	L	-	-	-	S	-	-	-	L	-	L
CO2	S	M	L	L	L	-	-	-	S	-	-	-	L	-	L
CO3	S	M	L	L	L	-	-	-	S	-	-	-	L	-	L
CO4	S	M	L	L	L	-	-	-	S	-	-	-	L	-	L
CO5	S	M	L	L	L	-	-	-	S	-	-	-	L	-	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Trade	Observation/Viva	Record	Model Test	Total Marks
CO1	10	2	25	100
CO2	10	2		
CO3	15	2		
CO4	20	2		
CO5	10	2		

- Students will be evaluated in any two trades. Each trade of 1 hour and 30 mins duration

List of Experiments

No.	Experiment	CO
1.	**Plumbing Exercise:** Assemble of plumbing pipeline circuit for domestic application (Any one Plumbing Exercise) – **4 hours**	CO1
2.	**Fitting Exercises:** Preparation of Square/V/L/Gauge/Taper Fitting (Any one Fitting Exercises) – **4 hours**	CO2
3.	**Sheet Metal Exercises:** Preparation of Dustpan/Tray/ Liter Cone - (Any one sheet metal Exercise) – **6 hours**	CO3
4.	**Carpentry Exercises**: Preparation of wooden parts like Photo frame/Office tray (Any one Carpentry Exercise) – **6 hours**	CO4
5.	**Arc welding Exercises**: Preparation of lap/butt joint using arc welding process (Any one Welding Exercise) – **4 hours**	CO5

Learning Resources

1. Laboratory Manual
2. John K.C “Mechanical Workshop”, Practice by Prentice Hall India Learning Private Limited, Second edition, 2010.

Course Designers

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22CE280	SURVEY LABORATARY

Category	L	T	P	Credit
PCC	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, levels

Prerequisite

Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Compute the area enclosed in a traverse using chain	TPS 3	A+	80
CO2	Compute the included angle and area of a closed traverse using prismatic compass	TPS 3	A+	80
CO3	Plot the ground features by using Plane table	TPS 3	A+	80
CO4	Locate the elevation of points and plot LS and CS of the given terrain using levels	TPS 3	A+	80

Mapping 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
CO1	S	M	L	M	-	M	-	M	-	L	-	-	M	L
CO2	S	M	L	M	-	-	-	M	-	L	-	-	M	L
CO3	S	M	L	M	-	M	-	-	-	L	-	-	M	L
CO4	S	M	L	S	-	M	-	-	-	L	-	-	M	L

S- Strong; M-Medium; L-Low

List of Experiments/Activities with CO Mapping

Sl No	Description	No of Hours	Course Outcome
1	Chain surveying - Ranging and chaining	4	CO1
2	Chain surveying -Calculation of Area in closed traverse		
3	Compass survey – Calculation of included angle	4	CO2
4	Compass survey – Local attraction problem		
5	Plane table survey – Radiation, Intersection	2	CO3
6	Plane table survey – Two-point problem	2	
7	Plane table survey – Three-point problem –Tracing paper		
8	Plane table survey – Three-point problem –Right angle	2	
9	Plane table survey – Three-point problem –Bessel method		
10	Find the elevation of the given points by running fly Levelling	4	CO4
11	Find the difference in elevation between the two points by differential levelling.	2	
12	Determine the profile of the ground by profile levelling and Cross-section levelling	2	
13	Contouring	2	

Learning Resources

1. Punmia,B.C, Ashok K Jain and Arun K Jain, " Surveying" Vol. I&II, Laxmi Publication, 17th Edition, New Delhi, 2016.
2. Survey lab Manual

Course Designers:

1. Dr. K. Sudalaimani ksudaliamani@tce.edu
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3. Dr R Ponnudurai rpdciv@tce.edu

22CE310	FOURIER SERIES AND PARTIAL DIFFERENTIAL EQUATIONS

Category	L	T	P	C	Terminal Exam Type
BSC	3	1	-	4	Theory

Preamble

This course introduces the basics of partial differential equations and the techniques to solve such equations which are widely used in modelling and analysis of a wide range of physical phenomena across all branches of engineering. It also develops students' skill in formulation, solving, understanding and interpretation solutions of PDE models. At the end of the course, former ideas are combined to solve boundary value problems for a particular partial differential equation such as wave propagation and heat phenomena.

Prerequisite

22MA110 - Calculus for Engineers

Course Outcomes

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

CO	Course Outcomes	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Compute Fourier series of functions in engineering applications.	TPS3	75	70
CO2	Formulate the partial differential equations to various physical phenomena	TPS2	80	75
CO3	Solve the partial differential equations using appropriate methods.	TPS3	75	70
CO4	Employ the techniques of Fourier series to boundary value problems such as vibration of string and one-dimensional heat flow.	TPS3	75	70
CO5	Adopt Fourier series techniques to solve problems such as two-dimensional heat flow in cartesian and polar coordinates	TPS3	75	70
CO6	Apply the techniques for numerical solution of second order partial differential equations of different categories.	TPS3	75	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Assessment	CAT 1			CAT 2			Terminal exam			Assignment 1			Assignment 2		
TPS / COs	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	4	10	36	-	-	-	-	6	18	-	-	58	-	-	-
CO2	3	10	-	-	-	-	-	6	-	-	-	-	-	-	-
CO3	3	10	24	-	-	-	-	6	12	-	-	42	-	-	-
CO4	-	-	-	3	10	20	-	6	12	-	-	-	-	-	35
CO5	-	-	-	-	-	17	-	-	10	-	-	-	-	-	15
CO6	-	-	-	7	20	23	-	6	18	-	-	-	-	-	50

Syllabus

Fourier Series: Introduction – Euler's formulae – Conditions for Fourier expansion – Functions having points of discontinuity - Change of interval - Odd and even function-Expansion of odd or even periodic functions – Half range series – Parseval's formula– Complex form of Fourier series – Harmonic analysis. **Partial differential equations:** Formation of partial differential equations– Solutions of a partial differential equation – Equations solvable by direct integration –Linear equations of the first order–Nonlinear equations of first order – Homogeneous linear equations with constant coefficients – Rules for finding the complementary functions - Rules for finding the particular integrals -working procedure tosolvehomogeneousandnon-homogeneouslinearequations.**Applications of Partial Differential Equations:** Method of separation of variables - Vibrations of a stretched string – Wave equations – One - dimensional heat flow problems – Two-dimensional heat flow – Solution of Laplace equation in Cartesian and polar coordinates. **Numerical solution of Partial differential equations:** Classification of second order partial differential equations –Elliptic equation – solution of Laplace and Poisson equations – Parabolic equations –Solution of heat equation - Hyperbolic equations – Solution of wave equation.

Reference Books

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 42nd Edition, 2012.
2. PeterV.O. Neil,"AdvancedEngineeringMathematics",7thedition,Cengage Learning,2017.
3.Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, New Delhi,2016.
4. P.Kandasamy, K.Thilagavathy and K.Gunavathi, "Engineering Mathematics", Volume-III, S.Chand & Company Ltd, Fourth Edition,2008.
5. T. Veerarajan,"EngineeringMathematics",3rdEdition,TataMcGrawHill,NewDelhi,2004.

Course Contents and Lecture Schedule

No.	Topic	No. of Periods
1.	**Fourier Series**	
1.1	Introduction, Euler's formulae, conditions for Fourier expansion, Functions having points of discontinuity	2
1.2	Change of interval	1
	Tutorial	1
1.3	Odd and even functions, Expansions of odd or even periodic functions	1
1.4	Half range series	2
	Tutorial	1
1.5	Parseval's formula and Complex form of Fourier series	1
1.6	Harmonic analysis	2
	Tutorial	1
2.	**Partial Differential Equations**	
2.1	Formation of partial differential equations	2
	Tutorial	1

No.	Topic	No. of Periods
2.2	Solutions of a partial differential equation, Equations solvable by direct integration	1
2.3	Linear equations of the first order	1
2.4	Non-linear equations of the first order	2
	Tutorial	1
2.5.	Homogeneous linear equations with constant coefficients, Rules for finding the complementary function, Rules for finding the particular integral.	1
2.6.	Working procedure to solve homogeneous and non-homogeneous linear equations.	2
	Tutorial	1
3	**Applications of Partial Differential Equations**	
3.1	Method of separation of variables	2
3.2	Vibrations of a stretched string - Wave equation	2
	Tutorial	1
3.3	One-dimensional heat flow	2
	Tutorial	1
3.4	Two-dimensional heat flow, solution of Laplace's equation in Cartesian coordinates	2
3.5	Two-dimensional heat flow, solution of Laplace's equation in Polar coordinates	1
	Tutorial	1
4	**Numerical solution of Partial differential equations**	
4.1	Classification of second order partial differential equations	1
4.2	Elliptic equations: Solution of Laplace and Poisson equations	2
	Tutorial	1
4.3	Parabolic equations: Solution of heat equation	3
	Tutorial	1
4.4	Hyperbolic equations: Solution of wave equation	3
	Tutorial	1
	Total	48

Course Designers:

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22CE320	MECHANICS OF SOLIDS

Category	L	T	P	Credit
PCC	2	1	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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Compute axial and bending stress.	TPS3	B	65
CO2	Select sections for circular shafts.	TPS3	B	65
CO3	Determine slope and deflection of determinate beams.	TPS3	B	65
CO4	Calculate forces in a member of truss.	TPS3	B	65
CO5	Demonstrate the effect of moving loads and to construct influence line diagram for determinate beams.	TPS3	B	65
CO6	Analyse suspension cables, three hinged stiffening girders and three hinged arches.	TPS3	B	65

*** Weightage depends on Bloom's Level, number of contact hours,

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern:

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	4	2	2	-	-	-	-	-	-	-	-	-	2	-	10	-	-	-	-	-	20		-	-	-	-	-	-	-	-
CO2	4	4	3	-	-	-	-	-	-	-	-	-	2	2	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	4	2	3	-	-	-	-	-	-	-	-	-	2	2	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	4	4	30	-	-	-	2	2	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO5	-	-	-	-	-	-	4	-	20	-	-	-	2	-	10	-	-	-	-	-	-	-	-	-	-		20	-	-	-
CO6	-	-	-	-	-	-	4	4	30	-	-	-	2	2	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-

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.

Learning Resources

1. S S Rattan., Strength 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. Junarkar, 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 Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	Course Outcome
1.0	**Axial and Bending Stresses**		
1.1	Direct and bending stresses	1	CO1
1.2	Uniaxial and biaxial eccentricities	1	
1.3	Middle third rule, core of the section	1	
1.4	Analysis of long column, different end conditions	1	
	Tutorial	1	
1.5	Euler's theory, Rankine's formula	1	
	Tutorial	1	
2.0	**Torsion of circular shafts**		
2.1	Introduction, derivation of torsion equation	2	CO2
2.2	Power transmitted by shafts and design of shafts	2	
	Tutorial	2	
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	1	CO3
	Tutorial	1	
3.2	Macaulay's Method	2	
	Tutorial	1	

3.3	Moment area method	2	
4.0	**Analysis of Trusses**		
4.1	Force in members of a truss by Method of Joints	2	CO4
	Tutorial	1	
4.2	Force in members of a truss by Method of Sections	2	
	Tutorial	1	
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	CO5
	Tutorial	2	
6.0	**Cables, Suspension Bridges and Arches**		
6.1	Analysis of suspension cables	2	CO6
6.2	Three hinged stiffening girders	1	
	Tutorial	1	
6.3	Three hinged arches	1	
	Tutorial	1	
	Total Hours (24 Hrs+12 Hrs)	**36 Hrs**	

Course Designers:

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22CE330	FLUID MECHANICS

Category	L	T	P	Credit
PCC	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 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

Basic Concepts of Physics and Mathematics

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Apply the knowledge of fluid properties in real fluid flow problems.	TPS3	A	70
CO2	Use the knowledge of Pascal's law and Hydrostatic law to find the pressure of the static and flowing fluid.	TPS3	A	70
CO3	Find the velocity and acceleration of fluids in pipes.	TPS3	A	70
CO4	Apply Bernoulli's theorem to solve a variety of fluid flow problems.	TPS3	A	70
CO5	Differentiate the laminar and turbulent flow in pipes. Also to calculate the losses in pipes.	TPS3	A	70
CO6	Apply the concept of boundary layer and its growth in real fluid flow problems.	TPS3	A	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	**CAT1**			**CAT2**			**Terminal**			**Assignment 1**			**Assignment 2**		
TPS Scale	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1	4	7	25	-	-	-	2		12	-	-	30	-	-	-
CO2	3	7	25	-	-	-	2		12	-	-	30	-	-	-
CO3	3	6	20	-	-	-	2		12	-	-	40	-	-	-
CO4	-	-	-	4	7	25	2	10	12	-	-	-	-		50
CO5	-	-	-	3	7	25	-	10	12	-	-	-	-		50
CO6	-	-	-	3	6	20	2	10	-	-	-	-	-		-

Syllabus

Fluid Properties: Density, Specific weight, Specific volume, Specific gravity, Viscosity, Kinematic viscosity, Surface tension, Compressibility, Capillarity, types of fluids. **Pressure Measurements:** Pascal's law, Hydrostatic law, Manometers, hydrostatic forces on vertical and horizontal plane surfaces, **Fluid Kinematics:** Types of fluid flows, continuity equation, velocity and acceleration, potential function and stream function. **Fluid Dynamics:** Euler's equation, Bernoulli's equation and its applications. **Flow Measurements:** Flow measurements in pipes using Pitot tube, Venturimeter and Orificemeter. **Flow through pipes:** Reynold's experiment, Laminar and turbulent flow through circular pipes, major and minor losses in pipes, flow through syphon, flow through pipes in series and parallel. **Boundary Layer Theory:** Boundary layer theory and its application, drag force on a flat plate

Learning Resources

1. Modi P.N and Seth S.M, "Hydraulics and Fluid Mechanics Including Hydraulic Machines" Standard Book House" New Delhi, 22nd Edition 2019
2. Yunus A. Cengel and John M. Cimbala, "Fluid Mechanics" Fundamentals and Applications, Tata McGraw Hill Publishing Company Ltd, New Delhi, 4th Edition 2019
3. Bansal R.K, "A Text Book of Fluid Mechanics and Hydraulic Machines" Lakshmi Publications, New Delhi, 10th Edition 2019
4. Kumar.K.L, "Engineering Fluid Mechanics" S.Chand Ltd., New Delhi, 2016.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**Properties of fluids**		CO1
1.1	Basic concepts of fluid mechanics, types of fluids	1	
1.2	Properties of fluids and its importance	2	
1.3	Problems on properties of fluids	2	
2	**Pressure and its measurement**		CO2
2.1	Pascal's law, Hydrostatic law	1	
2.2	Types of manometers and its applications	2	
2.3	hydrostatic forces on vertical and horizontal plane surfaces	2	
3	**Fluid Kinematics**		CO3
3.1	Classification of fluid flows	1	
3.2	Continuity equation for three dimensional flow and problems	2	
3.3	Velocity and acceleration of flow in pipes	1	

3.4	Concept of velocity potential function and stream function with problems	2	
4	**Fluid Dynamics**		CO4
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	1	
4.4	Pitot-tube and its application	1	
4.5	Venturimeter, Orificemeter and its applications	2	
5	**Flow through pipes**		CO5
5.1	Reynold's experiment to determine the type of flow	1	
5.2	Hagen Poiseuille equation	1	
5.3	Problems on laminar flow through pipes	1	
5.4	Turbulent flow-Darcy Weisbach equation	1	
5.5	Problems on turbulent flow through pipes	2	
5.6	Major and minor losses in pipes	2	
5.7	Flow through syphon pipe	1	
5.8	Flow through pipes in series and parallel.	2	
6	**Boundary Layer Theory**		CO6
6.1	Development of boundary layer thickness and its application	1	
6.2	Problems on boundary layer thickness and drag force on flat plate	2	
	Total Hours	**36**	

Course Designer(s):

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22CE340	WATER SUPPLY ENGINEERING

Category	L	T	P	Credit
PCC	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

CO Number	Course Outcome Statement	TCE Proficiency scale	Expected Proficiency	Expected Attainment Level %
CO1	Estimate the total water demand for a town/city and to Identify suitable sources to meet the demand.	TPS3	A	65
CO2	Fix the physical, chemical, and biological characteristics of different sources of water	TPS3	A	65
CO3	Design an appropriate treatment system for the water available at different surface sources	TPS3	A	65
CO4	Design an appropriate treatment system for the water available at different sub-surface sources	TPS3	A	65
CO5	Design the conduits for the transportation of water from the source to the treatment plant and to the city	TPS3	A	65
CO6	Plan and design a water distribution system for a building/city.	TPS3	A	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	10	10	20	-	-	-	-	-	-	-	-	-	2	6	10	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO2	5	10	10	-	-	-	-	-	-	-	-	-	2	12	-	-	-	-	-	-	30		-	-	-	-	-	-	-	-
CO3	5	10	20	-	-	-	-	-	-	-	-	-	2	6	10	-	-	-	-	-	30		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	15	10	-	-	-	2	12	-	-	-	-	-	-	-	-	-	-	-		30	-	-	-
CO5	-	-	-	-	-	-	5	10	15	-	-	-	2	6	10	-	-	-	-	-	-	-	-	-	-		30	-	-	-
CO6	-	-	-	-	-	-	5	15	20	-	-	-	2	6	10	-	-	-	-	-	-	-	-	-	-		40	-	-	-

Syllabus

Demand Estimation - Importance and need for planned water supply, water demand – Types, per capita demand, factors affecting per capita demand, variation in demand, Design periods and population forecasting, different methods. **Identification of sources, -** Sources of water, Surface sources-ponds-lakes-streams- rivers, Groundwater sources, occurrence, aquifers and their types, Wells - open wells, Tube wells, springs and their types, Infiltration galleries, Infiltration wells,. Intakes and their types **Quality Assessment** - Quality of water, Physical quality, chemical quality, Biological quality, waterborne diseases, Water quality standards. **Treatment of water** – Screening - Sedimentation – theory, types of settling, Stokes law - Coagulation – theory, chemicals - Jar test, design of sedimentation tank, Filtration – removal mechanisms, filter media, types, slow sand, rapid sand and pressure filters, filter design. Disinfection, Chlorination – action, factors influencing, free chlorination, combined chlorination, ozonation, UV radiation, Treatment of subsurface water-water softening, Desalination, Reverse Osmosis, Iron, manganese and arsenic removal-Advanced water treatment techniques-water treatment practices in rural areas. **Transport of water**, hydraulic design of pressure pipe, Pipe materials, pipe joints, pipe appurtenances, testing of pipe line, Pumps for lifting water and its types. **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, piping systems, recycled water, Two pipe system, usage of software

Learning Resources

1. Garg S.K "Water Supply Engineering", Khanna Publishers, 34th Edition, New Delhi 2015.
2. Steel E.W., "Water Supply and sewerage", Mc Graw Hill Publishers, New Delhi. 2000.
3. Peavy, Rowe, Tchobanoglous, "Environmental Engineering", McGraw Hill Publishers, New Delhi. 2006.
4. Birdie G.S and Birdie J.S "Water Supply and Sanitary Engineering" Dhatpat Rai Publishing Company New Delhi, 7th edition 2004
5. Gilbert M. Masters , " Introduction to Environmental Engineering and Science", third Edition, 2008
6. Manual on Water Supply and Treatment, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.
7. Chatterjee A.K. Water Supply, Waste Disposal and Environmental Engineering, 8th ed., New Delhi, Khanna Publisher. 2010
8. IS10500:2012 Water Quality Standards,New Delhi 2012
9. IS SP 26 – Handbook on Water supply and Drainage (with special emphasis on plumbing).

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods	CO
1	**Demand Estimation**		
1.1	Importance and need for planned water supplies.	1	CO1
1.2	Water demand – Types,	1	CO1
1.3	Per capita demand, factors affecting per capita demand. Variation in demand, Design periods.	1	CO1
1.4	Population forecasting – Different methods	2	CO1
1.5	Sources of water: Surface sources: ponds, lakes, streams, rivers	1	CO1
1.6	Ground water sources	1	CO1
1.7	Intakes and their types	1	CO1
2	**Quality Assessment**		
2.1	Quality of water – Physical quality, chemical quality	1	CO2
2.2	Biological quality	1	CO2
2.3	Water borne diseases, Water quality standards		CO2
3	**Treatment systems for surface water sources**		
3.1	Objectives of treatment of water – Screening	1	CO3
3.2	Sedimentation – theory, types of settling, Stokes law	1	CO3
3.3	Coagulation – theory, chemicals used, flocculation, Jar test.	1	CO3
3.4	Design of sedimentation tank	1	CO3
3.5	Filtration – Filter media - removal mechanisms, Slow sand filter	1	CO3
3.6	Rapid sand and pressure filters	2	CO3
3.7	Filter design	2	CO3
4	**Treatment systems for sub-surface water sources**		
4.1	Disinfection – methods, Ozonation and UV radiation	1	CO4
4.2	Chlorination – action, factors influencing	1	CO4
4.3	Water softening- Desalination	1	CO4
4.4	Reverse Osmosis –iron, manganese and arsenic removal treatment of water	1	CO4
4.5	Water treatment practices in rural areas.	1	CO4
5	**Transport of water**		
5.1	Hydraulic design of pressure pipe	2	CO5
5.2	Pipe materials, pipe joint, Pipe appurtenances, testing of pipe line.	1	CO5
5.3	Pumps for lifting water – types.	1	CO5
6	**Water Distribution**		
6.1	Distribution systems – requirements, layouts, methods.	1	CO6
6.2	Distribution reservoirs – storage capacity, mass curve method- Tutorials	2	CO6
6.3	Leak detection	1	CO6
6.4	Analysis of distribution network - Hardy Cross method – Tutorials	2	CO6
6.5	Water supply system in buildings – house connection, pipe fittings, storage tanks, piping systems.	1	CO6
6.6	Two pipe system, recycled water, usage of software	1	CO6
	Total hours	**36**	

Course Designers:

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22CE370	C PROGRAMMING LABORATORY

Category	L	T	P	Credit
ESC	0	0	2	1

Preamble

The laboratory course is designed to facilitate the students to solve simple mathematical, numerical and engineering problems using C programming language. The list of experiments starts with implementation of fundamental concepts, various control structures, array handling methods, string manipulations, use of functions, structures and files in C programming language. Then, the concepts learnt are applied by taking case studies in the appropriate engineering domain. These experiments will build up the concepts learnt in the corresponding theory course.

Prerequisite

Nil

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level%
CO1	Demonstrate the working of fundamental algorithms using data types, constants and expressions in C language	TPS3	B+	80
CO2	Illustrate different control structures in C for solving the simple mathematical and engineering problems	TPS3	B+	80
CO3	Make use of array processing techniques to perform matrix manipulations.	TPS3	B+	80
CO4	Solve problems related to string manipulations, sorting and searching using functions or recursion as applicable	TPS3	B+	80
CO5	Write programs in C using files and structures to store, retrieve and process data	TPS3	B+	80
CO6	Experiment the case studies in civil engineering domain and solve using C programs	TPS3	B+	80

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Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

List of Experiments/Activities with CO Mapping

Experiments	No of Hours	CO
Implement C programs using fundamental algorithms • Calculating simple Interest • converting the temperature from Celsius to Fahrenheit • Area and perimeter of rectangle	1	CO1
Implement C programs using selection and repetition control structures • Simple Arithmetic Calculator • Grade Computation • Biggest of three numbers • Sum of set of numbers	2	CO2
Implement C programs for array handling • Maximum/ Minimum element in an array • Read n number of values in an array and display it in reverse order • Copy elements of one array to another array	1	CO3
Implement C programs for matrix manipulations • Matrix Addition, Subtraction and Multiplication	1	CO3
Implement C programs using functions • Swap of two numbers using call by value and call by reference • Find GCD using function	1	CO4
Develop C programs using recursion • Fibonacci Series • Factorial Computation	1	CO4
Develop C programs for string manipulations • Implement string operations such as string concatenation, copy, length	1	CO4
Implement C programs to implement different sorting and sorting methods • Linear Search • Bubble sort	1	CO4
Develop C programs using structures and files • Storage, Retrieval and Processing of student data • Read and Write operations on text files	1	CO5
Implementation of any two case studies related to civil engineering using C programs	2	CO6
Total Hours	**12**	

Learning Resources:

Text Book

1. Byron S Gottfried, “Programming with C”, 4th edition, Schaum’s Outlines, 2018.

Reference Books& web resources

1. Yashwant Kanetkar, “Let us C”, 18th Edition, BPB Publications, 2021.
2. Kernighan, B.W and Ritchie,D.M, The C Programming language, Second Edition, Pearson Education, 2015.
3. Balagurusamy E , Programming In ANSI C , Seventh Edition, Tata Mc-Graw Hill, 2017.

Course Designers:

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2. P.Vijaya Praba, Assistant Professor, IT pvpit@tce.edu

22CE380	DIGITAL SURVEY LABORATORY

Category	L	T	P	Credit
PCC	0	0	2	1

Preamble

Knowledge of basic survey methods is essential in order to determine the distance and heights of the objects using stadia, tangential as well as trignometrical principle by using theodolite and Total station

Prerequisite

Nil

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Use the surveying equipments like Theodolite and Total Station in measuring horizontal and vertical angles.	TPS3	A	80
CO2	Locate the position of the object using stadia and tangential method of survey.	TPS3	A	80
CO3	Locate the position of the object using trigonometrical principle.	TPS3	A	80
CO4	Measure the distance and elevation of a remote object using Total Station.	TPS3	A	80

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

List of Experiments:

S. No	Description	No of Hours	Course Outcome
1.	Study of theodolite and measurement of horizontal angle by repetition and reiteration method.	4	CO1
2.	Determine the distance and heights of the objects using Stadia tacheometric method	2	CO2
3.	Determine the distance and heights of the objects using tangential tacheometric method	2	
4.	Find the gradient between two points using stadia and tangential principle.	2	
5.	Find the distance and elevation of the inaccessible (single) object by single plane method.	2	CO3
6.	Find the distance and elevation of the inaccessible (single) object by double plane method	2	
7.	Find the elevation of the inaccessible (double) object by double plane method.	2	
8.	Determine the elevation of the given point using subtense bar.	2	
9.	Measurement of horizontal, sloping and vertical distances of the object using Total station.	2	CO1, CO4

10.	Measurement of Remote Elevation measurement (REM) and Remote Distance measurement (RDM)	2	CO4
11.	Setting out a simple curve using Total Station.	2	CO4
Total Hours		**24**	

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22CE410	PROBABILITY STATISTICS AND NUMERICAL METHODS

Category	L	T	P	C	Terminal Exam Type
BSC	3	1	-	4	Theory

Preamble

Statistics and Probability are the main tools for an engineer for the processing, comparison, analysis interpretation of data. In this context the concepts on Statistics and Probability are added. Recently the idea of numerical solutions has a reasonable impact on needed topics various branches of engineering. In this regard the ideas on Numerical solution to algebraic and system of equations and ODEs are added. Finally, to signify the process of Numerical differentiation and integration the rudiments of difference calculus are included.

Prerequisite

NIL

Course Outcomes

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

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Compute the measures of central tendency and interpret their significance in the relevant area of study	TPS2	80	75
CO2	Compute the measures of correlation and regression and apply them in the needy context	TPS3	75	70
CO3	Apply the concept of probability through standard distributions and apply them in suitable situations of study	TPS3	75	70
CO4	Understand the numerical solution of algebraic and transcendental equations	TPS2	80	75
CO5	Solve the system of linear algebraic equations using appropriate methods	TPS3	75	70
CO6	Apply the process of Numerical Differentiation and Integration through the idea of difference calculus and the process of interpolation.	TPS3	75	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Assessment	CAT 1			CAT 2			Terminal exam			Assignment 1			Assignment 2		
TPS / COs	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	4	20	-	-	-	-	-	12	-	-	-	-	-	-	-
CO2	3	-	30	-	-	-	-	-	16	-	-	45	-	-	-
CO3	3	10	30	-	-	-	-	6	14	-	-	55	-	-	-
CO4	-	-	-	3	10	-	-	6	-	-	-	-	-	-	-
CO5	-	-	-	3	10	17	-	-	16	-	-	-	-	-	35
CO6	-	-	-	4	10	43	-	6	24	-	-	-	-	-	65

Syllabus

Descriptive Statistics: Descriptive statistics –Mean, median, mode, Geometric mean, Harmonic mean- Measures of Dispersion: Range, Quartile deviation, mean deviation and standard deviation - Coefficient of variation - Correlation - coefficient of correlation- - Lines of Regression –Rank correlation- properties of regression coefficients - Principle of least squares- Method of Least squares – Fitting of other curves. **Probability Distributions:** Random experiment - Conditional probability - Baye's Theorem-Random variables – Discrete Probability distributions – Continuous Probability distributions – Expectation-Binomial Poisson and Normal Distribution. **Numerical solution of equations:** Solution of Algebraic and Transcendental equations: Bisection method –Regula Falsi method -Newton-Raphson Method-Solution of Linear simultaneous equations- Direct Methods: Gauss Elimination and Gauss Jordan Methods-Iterative methods: Jacobi Iteration method -Gauss-Seidel iteration method. **Numerical Differentiation and Integration :** Difference operators-Relation between operators- Interpolation with equal intervals- Newton forward and backward interpolation formulae–Central Differences – Gauss forward and backward interpolation formulae – Interpolation with unequal intervals: Lagrange's interpolation formula- Numerical Differentiation: Formula for derivatives: Forward and backward difference formula- Central difference formula-Numerical integration: Trapezoidal Rule- Simpson's one-third and three-eight rules.

Reference Books

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 42nd Edition, 2012.
2. S.C. Gupta, V.K. Kapoor, "Fundamentals of Mathematical Statistics", Tenth Edition, Sultan Chand and Sons Educational Publishers, New Delhi, 2002
3. Jay L. Devore, "Probability and Statistics for Engineering and the Sciences" (English) Eighth Edition, Cengage Learning India Pvt Ltd, New Delhi, 2012.
4. P. Kandasamy, K. Thilagavathy, K. Gunavathi, Numerical methods, S. Chand& Company Ltd, New Delhi, 8th Edition, 2013
5. Miller, Fruend, "Probability and Statistics for Engineers", Prentice Hall of India, 2001.

Course Contents and Lecture Schedule

No.	Topic	No. of Periods
1.	**Descriptive Statistics**	
1.1	Mean, median, mode	2
1.2	Geometric mean, Harmonic mean	1
	Tutorial	1
1.3	Range, Quartile deviation, Mean deviation and standard deviation Coefficient of variation	2
1.4	Correlation - coefficient of correlation	1

	Tutorial	1
1.5	Lines of Regression	1
1.6	Rank correlation	1
	Tutorial	1
1.7	Principle of least squares- Method of Least squares	1
1.8	Fitting of other curves	1
	Tutorial	1
2.	**Probability Distributions**	
2.1	Random experiment-Conditional probability -Baye's Theorem	2
2.2	Random variables – Discrete Probability distributions	1
	Tutorial	1
2.3	Continuous Probability distributions	1
2.5	Expectation	1
2.6	Binomial, Poisson and Normal Distribution.	3
	Tutorial	1
3.	**Numerical Solution of Equations**	
3.1	Bisection method - Regula Falsi method	2
3.2	Newton-Raphson method	1
3.3.	Gauss Elimination and Gauss Jordan methods	2
	Tutorial	1
3.4	Factorization Method	1
3.5	Jacobi Iteration method - Gauss-Seidal iteration method	2
	Tutorial	1
4	**Numerical Differentiation and Integration**	
4.1	Difference operators-Relation between operators.	1
4.2	Interpolation with equal intervals: Newton forward and backward interpolation formulae	2
4.3	Central Differences – Gauss forward and backward interpolation formulae	2
	Tutorial	1
4.4	Interpolation with unequal intervals: Lagrange's interpolation formula	1
4.5	Numerical Differentiation: Formula for derivatives: Forward and backward difference formula, central difference formula	2
4.6	Tutorial	1
4.7	Numerical integration: Trapezoidal Rule-	1
4.8	Simpson's one-third and three-eight rules	2
	Tutorial	1
	Total	48

Course Designers:

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22CE420	STRUCTURAL ANALYSIS

Category	L	T	P	Credit
PCC	2	1	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 Engineering Mechanics and Mechanics of Solids.

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Construct ILD for indeterminate beams.	TPS3	B+	65
CO2	Analyse propped cantilever, fixed beam and frames by strain energy method.	TPS3	B+	65
CO3	Analyse propped cantilever, fixed beams and continuous beams using theorem of three moments.	TPS3	B+	65
CO4	Analyse beams and frames by slope deflection method.	TPS3	B+	65
CO5	Analyse beams and frames by moment distribution method.	TPS3	B+	65
CO6	Analyse beams and frames by matrix flexibility and stiffness method.	TPS3	B+	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern:

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	4	2	20	-	-	-	-	-	-	-	-	-	2	-	10	-	-	-	-	-	20		-	-	-	-	-	-	-	-
CO2	4	4	30	-	-	-	-	-	-	-	-	-	2	2	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	4	2	30	-	-	-	-	-	-	-	-	-	2	2	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	4	4	30	-	-	-	2	2	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-

CO5	-	-	-	-	-	-	4	-	20	-	-	-	2	-	10	-	-	-	-	-	-	-	-	-	-		20	-	-	-
CO6	-	-	-	-	-	-	4	4	30	-	-	-	2	2	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-

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 propped cantilever and fixed 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 and frames. **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.

Learning Resources

1. Wang.,C.K., " Indeterminate Structures" McGraw Hill Book Co., Newyork, 1994
2. Pandit G.S and Gupta S.P., " Structural Analysis – A Matrix Approach" Tata McGraw-Hill Publishing Ltd. New Delhi, 2007.
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.
5. Reddy,C.S., "Basic Structural Analysis", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2010
6. Junnarkar, S.B. & Shah, H.J.., Mechanics of structures, vol.I, II, Charotar Publishing House, India, 2000
7. Thandavamoorthy, ''Analysis of Structures", Oxford &IBH Publishers, New Delhi.2008
8. Jindal,R.L, "Indeterminate Sructures", S.Chand and Company Ltd., New Delhi 2000
9. NPTEL materials (http://nptel.ac.in/courses/105106050)

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	Course Outcome
1.0	**ILD for indeterminate beams**		
1.1	Muller Breslau's Principle	1	CO1
1.2	Influence line diagram for propped cantilever	1	
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	CO2
2.2	Analysis of continuous beams	1	
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	CO3
3.2	Analysis of continuous beams	2	
	Tutorial	2	
4.0	**Slope Deflection Method**		
4.1	Derivation of slope deflection equation	1	CO4
4.2	Analysis of continuous beams	1	
4.3	Analysis of portal frames 1	1	

	Tutorial	2	
5.0	**Moment Distribution Method**		
5.1	Definition of stiffness, carry over factor and distribution factor	1	CO5
5.2	Analysis of continuous beams	2	
	Tutorial	1	
5.3	Analysis of portal frames without side sway	1	
5.4	Analysis of portal frames with side sway	1	
	Tutorial	1	
6.0	**Matrix Methods**		
6.1	Structure stiffness matrix	1	CO6
6.2	Analysis of continuous beams by matrix stiffness method	1	
6.3	Analysis of portal frames without side sway by matrix stiffness method	1	
	Tutorial	1	
6.4	Analysis of continuous beams by matrix flexibility method	2	
	Tutorial	1	
	Total Hour (24+12)	**36**	

Course Designers:

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22CE430	HYDRAULICS AND HYDRAULIC MACHINERY

Category	L	T	P	Credit
PCC	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

Basic Concepts of Physics and Mathematics

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Design various types of open channel and most efficient channel sections	TPS3	A	70
CO2	Calculate the depth of the hydraulic jump	TPS3	A	70
CO3	Apply the principles of Dimensional and Model Analysis in hydraulic engineering problems.	TPS3	A	70
CO4	Compute the forces exerted by the jet of water on plates.	TPS3	A	70
CO5	Design and study the performance of various types of hydraulic turbines.	TPS3	A	70
CO6	Design and study the performance of various types of pumps.	TPS3	A	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1			CAT2			Terminal			Assignment 1			Assignment 2		
TPS Scale	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	4	7	25	-	-	-	2	5	14	-	-	30	-	-	-
CO2	3	7	20	-	-	-	2	5	14	-	-	30	-	-	-
CO3	3	6	25	-	-	-	2	5	14	-	-	40	-	-	-
CO4	-	-	-	4	7	20	-	5	-	-	-	-	-		-
CO5	-	-	-	3	7	25	2	-	14	-	-	-	-		50
CO6	-	-	-	3	6	25	2	-	14	-	-	-	-		50

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 and Weirs. **Dimensional Analysis:** Fundamental dimensions and derived quantity, Dimensional homogeneity, Rayleigh's method and Buckingham's π-Theorem, Similitude, Model testing, Dimensionless number. **Impact of jets:** Impact of jets on fixed and moving vanes. **Water turbines:** 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.

Learning Resources

1. Modi P.N and Seth S.M, "Hydraulics and Fluid Mechanics Including Hydraulic Machines" Standard Book House" New Delhi, 22nd Edition 2019
2. Bansal R.K, "A Text Book of Fluid Mechanics and Hydraulic Machines" Lakshmi Publications, New Delhi, 10th Edition 2019
3. Rajput. R.K, "A Text book of Fluid Mechanics and Hydraulic Machines", S.Chand and Company, New Delhi, 2016.
4. Subramanya K, "Flow in open channels", Tata McGraw-Hill Publishing Company, 5th Edition 2019.
5. Ramamrutham S and Narayanan R "Hydraulics, Fluid Mechanics and Fluid Machines", Dhanpat Rai Publishing Co (P) Ltd, New Delhi, 9th Edition 2014

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**Open Channel Flow**		
1.1	Introduction to open channel flow, Types of flow in channels	1	CO1
1.2	Chezy's equation, Empirical equation for the value of Chezy's constant	1	
1.3	Problems on rectangular and trapezoidal and circular channel section	2	
1.4	Most economical channel section, Condition for the most economical rectangular channel section.	1	
1.5	Condition for the most economical trapezoidal channel section.	2	
1.6	Condition for the most economical circular channel section.	1	
2	**Non-Uniform flow**		
2.1	Definition of Froude's number and Reynold's number , Definition of specific energy, specific energy diagram, critical depth, and critical velocity	1	CO2
2.2	Expression for depth of hydraulic jump & Expression for loss of energy due to hydraulic jump, Problems on hydraulic jumps	2	
2.3	Flow measurement in channels by notches and weirs	2	
3	**Dimensional Analysis and Model Analysis**		CO3
3.1	Introduction to dimensional analysis, fundamental dimensions, derived quantity, dimensional homogeneity and problems.	1	
3.2	Rayleigh's method and problems	1	

Module No.	Topic	No. of Hours	Course Outcome
3.3	Buckingham's Pi theorem and problems	2	
3.4	Similitude and model testing	1	
3.5	Dimensionless numbers and its application	1	
4	**Impact of Jets**		
4.1	Force exerted by the jet of water on stationery and moving vanes	1	CO4
4.2	Problems on symmetrical stationary and moving curved vanes	1	
	Problems on unsymmetrical moving curved vanes	1	
5	**Hydraulic Turbines**		
5.1	Introduction to water turbine and its classification, Pelton wheel & problems	2	CO5
5.2	Francis turbine working principle and problems	2	
5.3	Kaplan turbine working principle and problems	2	
5.4	Specific speed and cavitation in turbines	1	
6	**Pumps**		
6.1	Introduction to centrifugal pump & Description of working principles	1	CO6
6.2	Troubles and remedies in centrifugal pumps	1	
6.3	Performance characteristics, specific speed of centrifugal pumps, and selection of centrifugal pumps	2	
6.4	Introduction to reciprocating pump, single acting and double acting pump and slip	1	
6.5	Indicator diagrams	1	
6.6	Air vessels and acceleration head and power required	1	
	Total Hours	**36**	

Course Designer(s):

1. Mr. M.Ramasamy mrciv@tce.edu
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22CE440	WASTEWATER ENGINEERING

Category	L	T	P	Credit
PCC	3	0	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.

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected attainment level in %
CO1	Estimate the quantity of wastewater and storm run-off generated and design a suitable collection system for the rural/urban	TPS3	A	65
CO2	Identify the sewer appurtenances needed for the smooth functioning of the sewerage and to perform required maintenance operations for the system	TPS3	A	65
CO3	Characterize the wastewater generated from a town/ city and design necessary primary treatment units	TPS2	A	65
CO4	Design the necessary secondary treatment systems for the wastewater generated after its primary treatment.	TPS3	A	65
CO5	Identify the suitable mode of disposal for the treated wastewater without endangering the environment.	TPS3	A	65
CO6	Plan and design a house drainage system and to design a septic tank for isolated buildings.	TPS3	A	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	10	15	25	-	-	-	-	-	-	-	-	-	6	6	10	-	-	-	-	-	50		-	-	-	-	-	-	-	-
CO2	5	10	10	-	-	-	-	-	-	-	-	-	3	6	-	-	-	-	-	-	25		-	-	-	-	-	-	-	-
CO3	5	20	-	-	-	-	-	-	-	-	-	-	3	12	-	-	-	-	-	-	25		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	15	25	-	-	-	3	6	10	-	-	-	-	-	-	-	-	-	-		50	-	-	-
CO5	-	-	-	-	-	-	5	10	15	-	-	-	3	6	10	-	-	-	-	-	-	-	-	-	-		25	-	-	-
CO6	-	-	-	-	-	-	-	10	15	-	-	-	-	6	10	-	-	-	-	-	-	-	-	-	-		25	-	-	-

Syllabus

Collection of Sewage - Systems of sanitation, Sewerage - separate, combined and partially separate system. Estimating the quantity of sewage, dry weather flow,– hydraulic design of sewers, usage of software estimating storm run-off by the rational formula. **Transportation of Wastewater**, usage of software, Sewer materials, laying and testing of sewer, sewer appurtenances, cleaning and ventilation of sewers, pumping of sewage. **Characteristics of sewage** - decomposition – aerobic and anaerobic decomposition, physical and chemical quality of sewage, BOD and their testing, BOD equation, and problems, a population equivalent. Primary treatment of Wastewater- **Secondary treatment of sewage**, aerobic treatment, activated sludge process and its mechanism, design parameters and design, modifications in ASP, Trickling filters, process mechanism, types, design parameters and design, Hybrid system –MBBR (basics only), Natural systems, Ponds and Lagoons. Introduction to SBR and MBR. Anaerobic systems Fundamentals– UASB, anaerobic filters– Sludge characteristics, digestion tanks, design, disposal of digested sludge; Nutrient removal, tertiary treatment. **Impact of disposal of sewage** disposal by dilution, 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. Drainage system-plumbing system-types- Disposal of sewage in isolated buildings, Septic tank, Leach pit.

Learning Resources

1. Garg S.K.: "Sewage Disposal and Air Pollution Engineering",42nd edition 2022 Khanna Publishers New Delhi 2015.
2. Metcalf & Eddy:" Wastewater Engineering Treatment and Reuse" , Tata McGraw Hill Publishers, New Delhi, 2010.
3. Peavy, Rowe, Tchobanoglous, "Environmental Engineering", McGraw Hill Publishers, New Delhi, 2013.
4. Punmia B.C, Ashok Jain, "Wastewater Engineering", Laxmi publications, New Delhi, 1998.
5. Mark J.Hammer, Mark J.Hammer,Jr, "Water and Wastewater Technology", Prentice Hall of India Pvt.Ltd.,New Delhi,2011.
6. 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 Periods	CO
1	**Collection of sewage**		
1.1	Generation of sewage	1	CO1
1.2	Quantification of sewage- estimation	1	CO1
1.3	Estimation of storm runoff	1	CO1
1.4	System of sanitation		CO1
1.5	Estimation of storm runoff	2	CO1
2	**Transportation of wastewater**		
2.1	Hydraulic design of sewers	2	CO1
2.2	Sewer appurtenances	1	CO2
2.3	Maintenance of sewer	1	CO2
2.4	Pumping of sewage		CO2
2.5	Sewer material, laying and testing of sewer	1	CO2
3	**Characterization of sewage**		
3.1	Aerobic and anaerobic decomposition of sewage	1	CO3
3.2	Physical quality of sewage		CO3
3.3	Chemical quality of sewage	1	CO3
3.4	BOD, testing procedure and BOD equation	1	CO3
3.5	Problems in BOD and population equivalent		CO3

Module No.	Topic	No. of Periods	CO
3.6	Biological quality of sewage	1	CO3
3.7	Objectives of treatment – Physico - chemical treatment	1	CO3
4	**Secondary Treatment of wastewater**		
4.1	Aerobic treatment – activated sludge process- process mechanism	1	CO4
4.1.1	Methods of aeration	1	CO4
4.4.2	Design consideration and design	1	CO4
4.1.3	Modification in ASP	1	CO4
4.2	Trickling filters- process mechanism, types	1	CO4
4.2.1	Design consideration – standard rate trickling filter	1	CO4
4..2.2	Design of standard rate trickling filter	1	CO4
4.2.3	High-rate trickling filter- design	1	CO4
4.3	Hybrid system- SBR, MBR, MBBR	1	CO4
4.4	Natural systems – ponds and lagoons	1	CO4
4.5	Nutrient removal-Tertiary treatment		
4.5.1	Anaerobic system-Fundamentals- UASB	1	CO4
4.6	Anaerobic filter, natural system		CO4
4..6.1	Sludge digestion- characteristics of sludge, digestion tanks	1	CO4
4.6.2	Design of digestion tank and disposal of digested sludge		CO4
4.6.2	Sludge digestion tanks and Sludge Characteristics	1	CO4
5	**Impact of disposal of sewage**		
5.1	Impact of disposal of treated sewage – Impact on river	1	CO5
5.1.1	Self-purification of streams	2	CO5
5.1.2	Oxygen sag curve for streams		CO5
5.1.3	Streeter Phelps equation- problems		CO5
5.2	Impact on lakes- eutrophication	1	CO5
5.3	Impact on sea		CO5
5.4	Land irrigation- sewage farming	1	CO5
5.4.1	Sewage sickness	1	CO5
5.5	Drainage system in isolated buildings- septic tanks	1	CO6
5.6	Plumbing system- types	1	CO6
	Total hours	**36**	

Course Designers:

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22CE470	STRUCTURAL MECHANICS LABORATORY

Category	L	T	P	Credit
PCC	0	0	2	1

Preamble

This laboratory course is intended to give hands-on training to compute deformations, deflections, and internal forces or stresses (stress equivalents) in various structural models.

Prerequisites

Mechanics of structures

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level%
CO1	Analyze the behaviour of long columns with different end conditions.	TPS3	A+	75
CO2	Ascertain shear force, bending and deflection characteristics of simply supported and cantilever beam.	TPS3	A+	75
CO3	Determine various elastic constants for statically determinate beam	TPS3	A+	75
CO4	Determine the behaviour of portal frame and pin jointed truss.	TPS3	A+	75
CO5	Calculate the internal forces in cable and arch type structures.	TPS3	A+	75
CO6	Ascertain the deflection behaviour of curved members	TPS3	A+	75

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

List of Experiments/Activities with CO Mapping

S. No	Description	No. of hours	Course Outcome
1	Behaviour of different types of columns and determination of Euler's buckling load for each case.	2	CO1

2	To determine the central deflection of a simply supported beam loaded by a concentrated load at mid-point and hence determine the modulus of elasticity of the material of the beam.	2	CO2
3	To verify the moment area theorem regarding the slopes and deflections of the beam	2	
4	Behaviour of cantilever beam under symmetrical and unsymmetrical bending.	2	
5	To find the value of flexural rigidity (EI) for a given beam and compare it with theoretical value.	2	CO3
6	Determination of Modulus of rigidity of the given material of circular shaft.	2	
7	To determine the deflection of a pin connected truss analytically & graphically and verify the same experimentally.	2	CO4
8	Behaviour of portal frame under different end conditions	2	
9	To find horizontal thrust for two hinged arches.	2	CO5
10	To find horizontal thrust for three hinged arches.	2	
11	Behaviour of suspension bridge under different loading.	2	
12	Determination of Elastic displacement of curved members.	2	CO6
	Total Hours	**24**	

Learning Resources:

1. S S Rattan., Strength of Material, McGraw Hill Educational Private (India)Limited, 3rd edition,2017
2. Bhavikatti S S, "Structural Analysis", Vikas Publishing House Pvt. Ltd, New Delhi. 2011
3. Rajput., Strength of materials, S.Chand publishers, 6th edition, 2017
4. Punmia, B.C., Arun Kumar, Ashok Kumar., Theory of structures, Laxmi Publications, New Delhi, 2014.
5. Devdas Menon., Advanced Structural Analysis,Alpha Science International, 2017.
6. Reddy,C.S., "Basic Structural Analysis", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2010
7. Junnarkar, S.B. & Shah, H.J.., Mechanics of structures, vol.I, II, Charotar Publishing House, India, 2016

Course Designers

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22CE480	COMPUTER AIDED DRAFTING LAB

Category	L	T	P	Credit
PCC	--	--	2	1

Preamble

This laboratory course work is intended to provide students with opportunities to acquire knowledge and to develop skills in drafting the different views of the components of the building structures using available drafting software and capable of viewing and drawing the plan, elevation and section of the different types of the building. The course shows how to use drafting software to set up drawings and construct lines, circles, arcs, other shapes, geometric constructions, and text. Students will use display and editing techniques as well to obtain information about their drawings and work with drawing files. This course also introduces recommended drafting standards for students to use for properly preparing drawings with drafting software.

Prerequisites

Nil

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level%
CO1	Draw 2D drawing using basic drawing and editing commands	TPS3	A+	80
CO2	Manage the files, views, layers, and display commands	TPS3	A+	80
CO3	Create symbols using the concept of blocks, Wblocks & Xref	TPS3	A+	80
CO4	Publish and plot the drawing with annotations & Dimensioning,	TPS3	A+	80
CO5	Setting up of drawing in Layout Using the Concept of paper space & model space and specific scales.	TPS3	A+	80
CO6	Draw and edit 3D models using UCS	TPS3	A	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

List of Experiments/Activities with CO Mapping

S.No	List of Experiments	No. of hours	Course Outcome
	2D Drawings		
1	Draw a Fully panelled door / window / Partially panelled and partially glazed door / windows and show the plan, section & elevations with necessary dimensions and annotations	2	CO1,CO4
2	Draw a Single room building with necessary plan section and elevations	2	CO1,CO2, CO4
3	Draw a Single floor residential building plan with furniture usage of layers	2	CO1,CO2, CO3, CO4
4	Draw an Industrial Structure with cross sectional layer display	2	CO1,CO2, CO3, CO4
5	Draw a Fink/fink fan type steel trusses – detailing with various scale – usage of paper space & model space.	2	CO1,CO2, CO3, CO4
6	Draw a Two-storey storey residential building with plan, section and elevation using blocks	2	CO1, CO2, CO3, CO4
7	Draw the Master plan of College campus- using the concept of Xref	4	CO1, CO2, CO3, CO4
9	Draw a Dog legged stair case – necessary views	2	CO1, CO2, CO3, CO4
10	Design of a residential building for a given area and draw plan, section and elevation.	2	CO1, CO2, CO3, CO4
	3D Drawings		
11	3D modelling of a residential building and generating various views	4	CO1, CO4, CO5,CO6
	Total Hours	**24**	

Learning Resources

1. V.B. Sikka, A Course in Civil Engineering Drawing, 4th edition, S.K. Kataria & Sons, New Delhi, 2017.
2. M.G. Shah, C.M. Kale & S.Y.Patki, Building Drawing with an Integrated Approach to Built Environment, 4th edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi, 2002.
3. Geogre Omura and Brain C. Benton, Mastering AutoCAD and AutoCAD LT, J. Wiley & Sons, 2018
4. Ramsey and Sleeper, Architectural Graphic Standards Student Edition, J. Wiley & Sons, 2017

Websites:

1. https://www.mycadsite.com/tutorials/index.html
2. https://www.cadtutor.net/tutorials/autocad
3. http://www.caddprimer.com/AutoCAD_training_tutorial/AutoCAD_training_lessons.html.
4. http://www.autocadmark.com
5. http://www.autocadtutorials.net

Course Designers

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22CE490	PROJECT MANAGEMENT

Category	L	T	P	Credit
HSMC	2	1	0	3

Preamble

This course gives an exposure to the basic concepts involved in a project. Project management principles required to manage it with the need for network techniques and its applications to projects

Prerequisite

NIL

Course Outcomes

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

COs	Course Outcome	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Explain project, project management, life cycle and influencing factors, Knowledge areas of Project Management using PMBOK principles	TPS2	A	65
CO2	Analyze and Manage time in projects through Gantt charts and PERT techniques,	TPS 3	A	75
CO3	Analyze and Manage time in projects using CPM technique, update and monitor projects	TPS 3	A	75
CO4	Manage resources of project using resource smoothing and levelling techniques	TPS 3	A	65
CO5	Optimize resources of projects using scheduling, fast tracking and re-estimation techniques with CPM Cost Model.	TPS 3	A	65
CO6	Identify the need for awareness on emerging trends in project management. Brief introduction to Earned Value Management concept	TPS 2	A	65

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	10	5	-	-	-	-	-	-	-	-	-	-	2	10	-	-	-	-	-	-	20		-	-	-	-	-	-	-	-
CO2	5	10	30	-	-	-	-	-	-	-	-	-	2	-	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	5	5	30	-	-	-	-	-	-	-	-	-	2	-	20	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	5	30	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO5	-	-	-	-	-	-	5	5	30	-	-	-	2	-	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO6	-	-	-	-	-	-	10	10	-	-	-	-	2	10	-	-	-	-	-	-	-	-	-	-	-		20	-	-	-

Syllabus

Project and its process: Define project and process, Objectives and functions of Project management, organization structure / styles, roles of project management group, project integration, project life cycle- influencing factors. Knowledge management on Project Management from PMBOK- Case study. **Time Management**: Work break down structure. Project planning tools- Project Network- Fulkerson's rules – Activity-On-Arrow and Activity- On -Node networks. Analyze project time- using Gantt Chart, Program Evaluation & Review Technique – case study. Analysis of project with Critical path method - 80-20 rule (Pareto's rule)- Square network diagram. Precedence Diagramming Method- brief concept. Project updating and monitoring- Case study **Resource Management**: Types of resource in projects- Balancing of resource- Resource Smoothing technique- Resource leveling technique- - Case study. **Resource optimization**: Types of cost – Variation of Cost with time. Schedule Compression Techniques- Crash time and crash cost. Optimize project cost -CPM Cost model. **Emerging trends in project management**: Introduction to Theory of Constraints, Agile Project management, Earned Value Management - Case study

Text Book

Reference Books& web resources

1. Kumar Neeraj Jha, "Construction Project Management, Theory and Practice", Pearson Publications, 2018
2. Punmia B. C. and Khandelwal K.K., "Project Planning and Control with PERT/CPM", Laxmi publications, New Delhi, 1989.
3. "A Guide to the Project Management Body of Knowledge (PMBOK Guide)" - Fifth Edition, An American National Standard, ANSI/PMI 990001-2008.
4. Jerome D. Wiest and Ferdinand K. Levy, "A Management Guide to PERT/CPM", Prentice Hall of India Publishers Ltd., New Delhi, 1994.
5. Srinath L.S., "PERT & CPM- Principles and Applications", Affiliated East West Press Pvt., Ltd., New Delhi, 2008
6. A Risk Management Standard, AIRMIC Publishers, ALARM, IRM: 2002
7. Nptel videos at https://nptel.ac.in/courses/105106149/ by Dr. Koshy Varghese, Dept of Civil Engineering, IIT, Madras.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	COs
1.0 Project and its process			
1.1	Define project and process, boundaries of project	2	
1.2	Objectives and functions of Project management, characteristics of projects		
1.3	Roles of project management group, project management office and its role		
1.4	Project knowledge area, project integration- process group		

	interaction		CO1
1.5	Project flow, project life cycle- influencing factors, Case study		
1.6	Project Knowledge areas – Integration – project charter, Scope	2	
1.7	Project Knowledge areas – Time, Cost, Quality- Triple Constraints, Procurement	1	
1.8	Project Knowledge areas – HR, Risk, Communication, Stakeholder Management	1	
	Case study		
2.0 Time Management			
2.1	Project Scope Management, Work break down structure - Activity/ Task- Events- Case study- Rolling wave planning	2	CO2
2.2	Gantt Charts- concept and problems, Limitations of Gantt Chart, Milestone chart, Program Progress chart		
2.3	Project Network- Fulkerson's rules – A-O-A and A-O-N networks-Tutorial	2	
2.4	Estimate time- PERT (Probabilistic Approach)- Event oriented network analysis- Optimistic, Pessimistic & Most likely time, Degree of variability in average time, Probabilistic estimate, % utilization of resources	2	
	Tutorial	1	
3.0 Project Time Management			
3.1	Analyze project time- Critical path method (deterministic approach- activity oriented network analysis- Square network diagram-Tutorial	2	CO3
3.2	80-20 rule, type of time estimates - Case study		
3.3	Project updating and monitoring- Case study	2	
3.4	Tutorial	1	
4.0 Resource Management			
4.1	Types of resource- Time, Men, Material, Machinery, Money, Space. Balancing of resource- need and purpose- Case study	2	CO4
4.2	Resource Smoothing technique- Time constraint-Tutorial	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- Tutorials	2	CO5
5.2	Optimize project cost for time and resource- CPM Cost model- Case study. Precedence Diagramming Method- brief idea	3	
	Tutorials	1	
6.0Emerging Trends in Project Management			
6.1	Emerging trends in project management: (Brief concept only) Agile Project Management	1	CO6
6.2	Theory of Constraints	1	
6.3	Earned Value Management	2	
	Total Periods	**36**	

Course Designer(s):

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22CE510	SOIL MECHANICS

Category	L	T	P	Credit
PCC	3	0	0	3

Preamble

All structures are built on soils. To design safe and sound structures, engineers should have fundamental knowledge on the properties of soil, behavior of soil when it is subjected to loads from the built structures. This course deals with the application of laws of Mechanics and Hydraulics to solve engineering problems related with soils like flow of water through soil, Shear strength, Compressibility & Compaction characteristics of soil and Stress distribution in soil

Prerequisite

Nil

Course Outcomes

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

CO Number	Course Outcome	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Identify various types of soil, classify them and compute their index properties.	TPS3	B+	65
CO2	Understand the flow of water through soil medium and calculate the permeability of cohesive and cohesionless soils.	TPS3	B+	65
CO3	Illustrate the significance of soil compaction	TPS3	B+	65
CO4	Calculate effective stress within soils and compute stresses in soil due to external loads.	TPS3	B+	65
CO5	Compute the shear strength of soils based on the parameters obtained from shear tests.	TPS3	B+	65
CO6	Interpret the concept of consolidation and estimate the settlement of soil due to consolidation.	TPS3	B+	65

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Assessment	CAT1			CAT2			Terminal Exam			Assignment 1			Assignment 2		
TPS / COs	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	4	4	30	-	-	-	2	-	16	-	-	40	-	-	-
CO2	3	4	23	-	-	-	2	-	12	-	-	30	-	-	-
CO3	3	12	17	-	-	-	2	6	7	-	-	30	-	-	-
CO4	-	-	-	3	3	30	2	-	16	-	-	-	-		30
CO5	-	-	-	3	3	27	2	-	16	-	-	-	-		40
CO6	-	-	-	3	-	28	2	-	15	4	16	16	-		30

Syllabus

Origin and Properties of soils: Formation of soil - Commonly used soil designations - Phase relationships - Index Properties - Laboratory tests - Particle size distribution analysis - Determination of consistency limits and their significance to the field behaviour of soil - BIS Soil classification system. **Permeability:** Darcy's law and its validity - Determination of permeability in laboratory - Factors affecting permeability - Seepage analysis - Laplace's equation - Introduction to Flow nets. **Soil Compaction:** Concept of compaction - Standard proctor and Modified proctor compaction Tests - Factors affecting compaction - Field compaction methods and machineries. **Stress distribution in soil:** Concept of total and effective stress in saturated soil deposits – Quick sand condition-Liquefaction - Stresses due to external loads - Boussinesq's theory (Point load, UDL and Line Load) - Concept of pressure bulb - Approximate methods - Use of Newmark's influence chart - Westergaard's theory. **Shear Strength:** Shear strength of cohesive and cohesionless soils - Mohr-Coulomb failure criterion - Classification of shear test based on drainage conditions - Direct shear test - Unconfined compression test - Triaxial compression test - Vane shear test. **Compressibility:** Concept of consolidation - Terzaghi's theory of one-dimensional consolidation - Components of settlement - Computation of rate of settlement - Determination of C_V by $\sqrt{t}$method and log time method - Calculation of consolidation settlement

Text Book

1. Dr.Arora,K.R., "Soil Mechanics and Foundation Engineering", Standard Publishers Distributors, New Delhi,2020.

Reference Books&Web Resources

1. BrajaM. Das, "Fundamentals of Geotechnical Engineering", Fourth Edition, Cengage Learning, New Delhi,2014.
2. Murthy, V.N.S, "Soil Mechanics and Foundation Engineering", CBS Publishers Distribution Ltd., New Delhi,2015.
3. Gopal Ranjan and Rao, A.S.R., "Basic and Applied Soil Mechanics", New Age International (P) Limited, Publishers New Delhi (India),2013.
4. Robert D. Holtz, William D.Kovacs, Thomas C.Sheahan, "An Introduction to Geotechnical Engineering", Indian Edition, Dorling Kindersley India Pvt.Ltd., Noida,2017.
5. NPTEL Materialhttps://nptel.ac.in/courses/105103097/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Origin and Properties of soils**		
1.1	Formation of soil - Commonly used soil designations	1	CO1
1.2	Phase relationships - Index properties	1	
1.3	Laboratory tests	1	
1.4	Particle size distribution analysis	2	
1.5	Determination of consistency limits and their significance to the field behaviour of soil	2	
1.6	BIS soil classification system	1	
2.	**Permeability**		
2.1	Darcy's law and its validity - Determination of permeability in laboratory	2	CO2
2.2	Factors affecting permeability - Seepage analysis - Laplace's equation	2	
2.3	Introduction to Flow Nets	1	
3.	**Soil Compaction**		
3.1	Concept of compaction - Standard proctor and Modified proctor compaction Tests	2	CO3
3.2	Factors affecting compaction	1	
3.3	Field compaction methods and machineries	2	
4.	**Stress distribution in soil**		
4.1	Concept of total and effective stress in saturated soils deposits - Quick sand condition - Liquefaction	2	CO4
4.2	Stresses due to external loads -Boussinesq's theory (Point load, UDL and Line Load)	2	
4.3	Concept of Pressure bulb - Approximate methods - Use of Newmark's influence chart – Westergaard's theory	2	
5.	**Shear Strength**		
5.1	Shear strength of cohesive and cohesionless soils - Mohr-Coulomb failure criterion - Classification of shear test based on drainage conditions	2	CO5
5.2	Direct shear test - Unconfined compression test	2	
5.3	Triaxial compression test - Vane shear test	2	
6.	**Compressibility**		
6.1	Concept of consolidation - Terzaghi's theory of one-dimensional consolidation	2	CO6
6.2	Components of settlement - Computation of rate of settlement	2	
6.3	Determination of C_v by $\sqrt{t}$method and log time method - Calculation of consolidation settlement	2	
	Total Hours	**36**	

Course Designer(s):

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2. Ms. K. Muthu Prema kmpciv@tce.edu

22CE520	DESIGN OF STEEL ELEMENTS

Category	L	T	P	Credit
PCC	3	0	0	3

Preamble

The primary concern of an engineer is design. Structural design consists of 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, the exposure to IS:800 code provisions, Plastic analysis and design of bolted and welded connections, tie members, compression members, beam and column bases made of steel are dealt with. Further, the elements are designed for internal forces like tension, compression, bending moment and shear.

Prerequisite

22CE320-Mechanics of Solids

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (Grade)	Expected Attainment Level %
CO1	Demonstrate the force transferring mechanism and apply the principles in designing bearing type & HSFG type bolted connections	TPS3	B	65
CO2	Illustrate the force-transferring mechanism and apply the principle in designing the welded connections	TPS3	B	65
CO3	Apply the code provisions in estimating the capacity, and dimensioning the steel tension members.	TPS3	B	65
CO4	Compute the capacity and arrive at a compression member cross-section along with the suitable column base.	TPS3	B	70
CO5	Execute the plastic analysis of indeterminate beams and portal frames to predict collapse load factor / plastic Moment capacity.	TPS3	B	70
CO6	Apply the code provisions for the strength and stability assessment of flexure members with or without lateral support	TPS3	B	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Assessments	Assessment - I						Assessment - II						Terminal Exam		
	CAT1			Assignment-I*			CAT-II			Assignment -II*					
TPS COs	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	5	5	25	-	-	20	-	-	-	-	-	-	2	10	
CO2	5	5	20	-	-	40	-	-	-	-	-	-	2	-	15
CO3	5	5	25	-	-	40	-	-	-	-	-	-	2	-	20
CO4	-	-	-	-	-	-	5	5	25	-	-	20	-	-	20
CO5	-	-	-	-	-	-	5	5	20	-	-	40	2	10	-
CO6	-	-	-	-	-	-	5	5	25	-	-	40	2	-	15
Total	15	15	70	-	-	100	15	15	70	-	-	100	10	20	70

*Assignment I.II – Quiz/Case analysis/Problem-solving/Presentation/Writing Task

Syllabus

Introduction of Structural steel types, Mechanical Properties of structural steel, Indian structural steel products. **Design Philosophy of steel structures:** Introduction, Working stress method, Limit state method, Classification of cross sections, IS800:2007 related provisions. **Bolted connection:** Connection types, Introduction to riveted connections, Force transfer mechanism of bearing type & HSFG bolts, failure mechanism, Design, direct tension, compression, a moment in plane of the bolt, moment perpendicular to the bolt, Design of Slip critical connections **Welded connection:** Type of welds, joints, the strength of welds, Design, direct tension, compression, moment in plane of the weld, moment perpendicular to the weld. **Tension members:** Behaviour, Design of plate and angle tension members, design of built-up tension Members, Connections in tension members, Use of lug angles, Design of tension splice. **Compression members:** Type of Column sections, Design, rolled steel section, built-up section, laced and battened columns, Angle struts. **Column base:** Slab base and gusseted base. **Plastic Analysis:** Theory & assumptions yield criteria, plastic modulus & shape factor, plastic analysis of continuous beams, Plastic collapse loads of Single Storey rectangular portal frame & various mechanisms. **Flexure members:** Behaviour - Design, simple and compound beams, laterally restrained, laterally unrestrained, Factors affecting lateral stability, Shear Strength, Web Buckling, Crippling and deflection of Beams.

Indian Standard Codes

1. IS: 800 – 2007, Code of Practice for general construction in steel, BIS, New Delhi
2. SP 6 (1) – Structural steel sections, BIS, New Delhi
3. IS: 816 - 1969, Code of practice for use of metal arc welding for general construction in mild steel.
4. IS: 808 – 1989 Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Sections

Learning Resources

1. Duggal S.K., “Limit state design of steel structures” McGraw Hill Co., New Delhi, 2014
2. Teaching Resource for Structural Steel Design, Vol. 1,2,3 (2000), INSDAG- Institute for Steel Development and Growth, Kolkatta.
3. Subramanian, N., (2008), Design of Steel Structures, oxford university press, USA,.
4. Gaylord E H, Gaylord N C and Stallmeyer J E, “Design of Steel Structures”, 3rd edition, McGraw Hill Publications, 1992.
5. Salmon, Johnson & Malhas,” Steel Structures: Design and Behavior, 4th Edition, Harper Collins College Publisher, 1996
6. Negi L.S. “Design of steel structures” McGraw Hill Co., New Delhi, 2014
7. www.nptel.ac.in
8. http://www.steel-insdag.org/TM_Contents.asp

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**Introduction of Structural steel**		
1.1	Structural steel types – Mechanical Properties of structural steel- Indian structural steel products.	1	CO1
1.2	**Design Philosophy of steel structures:** Introduction – Working stress method – Limit state method	1	
1.3	Classification of cross sections- IS800:2007 related provisions.	1	
1.4	**Bolted connection:** Connection types & Introduction to riveted connections.	1	
1.5	Force transfer mechanism of bearing type & HSFG bolts-failure mechanism.	1	
1.6	Design of bolted connection - direct tension – compression.	1	
1.7	Design of bolted connection - moment in plane of the bolt	1	
1.8	Design of bolted connection - moment perpendicular to the bolt	2	
1.9	Design of Slip critical connections	2	
2	**Welded connection**		
2.1	Type of welds, joints – the strength of welds.	1	CO2
2.2	Design of welded connection – the moment in the plane of the weld	2	
2.3	Design of welded connection - moment perpendicular to the weld	2	
3.1	**Tension members:** Behaviour - Design of plate	1	CO3
3.2	Design of angle tension members.	1	
3.3	Design of built-up tension Members	1	
3.4	Connections in tension members – Use of lug angles - Design of tension splice.	2	
4	**Compression members:** Type of Column sections.	1	CO4
4.1	Design of rolled steel column	2	
4.2	Design of built up column - laced and battened columns.	2	
4.3	Design of Angle struts.	1	
4.4	**Column base:** Design of Slab base.	1	

4.5	Design of gusseted base.	1	
5	**Plastic Analysis**		CO5
5.1	Theory & assumptions yield criteria, plastic modulus.	1	
5.2	Shape factor - plastic analysis of continuous beams.	1	
5.3	Plastic collapse loads of Single Storey rectangular portal frame & various mechanisms.	2	
6	**Flexure members:** Behaviour - Design - simple and compound beams	1	CO6
6.1	Design of Laterally restrained beams –Shear Strength-Web Buckling, Crippling and Deflection of Beams.	1	
6.2	Design of Laterally unrestrained beams - Factors affecting lateral stability	1	
	Total Hrs.	36	

Course Designers:

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

22CE530	CONCRETE TECHNOLOGY

Category	L	T	P	Credit
PCC	4	0	0	4

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Explain the properties and tests of various constituents present in concrete	TPS3	B	65
CO2	Demonstrate various manufacturing process of concrete and properties and workability tests of fresh concrete	TPS3	B	65
CO3	Design concrete mix as per IS and ACI standards	TPS3	B	65
CO4	Enumerate the mechanical behaviour and properties of hardened concrete	TPS3	B	65
CO5	Demonstrate the long-term properties of concrete and identify the solutions for field problems	TPS3	B	65
CO6	Select the suitable type of special concrete for real time situations	TPS3	B	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern:

CO	CAT1			CAT2			Terminal			Assignment 1			Assignment 2		
TPS Scale	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1	4	4	30	-	-	-	2	2	15	-	-	40	-	-	-
CO2	4	2	30	-	-	-	2	2	15	-	-	40	-	-	-
CO3	4	2	20	-	-	-	-	-	20	-	-	20	-	-	-
CO4	-	-	-	4	2	30	2	2	10	-	-	-	-	-	40
CO5	-	-	-	4	2	30	2	2	10	-	-	-	-	-	30
CO6	-	-	-	4	4	20	2	2	10	-	-	-	-	-	30

Syllabus

Concrete making Materials: **Cement:** Raw materials; composition - Hydration, chemistry of cement; Types, Tests and specifications- Consistency, setting time, soundness and fineness test. **Aggregates:** Source- natural and artificial. Physical properties- gradation, fineness modulus, specific gravity, bulk density, bulking of sand, water absorption, moisture content, presence of deleterious content.Tests on coarse aggregates- impact, crushing, abrasion and attrition, alkali aggregate reaction. **Water:** Qualities of water for concreting- tolerable concentrations of impurities, sea water and its effects. **Concrete Production & Fresh properties:** 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. **Admixtures:** Types of Admixtures- super plasticizers, plasticizers, retarders, accelerators, air entrained admixtures and pozzolanic admixtures **Concrete mix proportion:** Concept of Mix proportion - 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: fibre reinforced concrete, high strength concrete, high performance concrete, reactive powder concrete, lightweight concrete and high-density concrete, self-compacting concrete, Polymer concrete, geo polymer concrete, Roller compacted concrete and Shotcrete.

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.

IS Codes

1. IS: 10262-2019, Recommended guidelines for Concrete Mix Design.
2. IS: 456 - 2000, (Reaffirmed:2021) Plain and Reinforced concrete – code of practice
3. SP: 23 - 1982, Handbook on concrete.
4. IS: 269 - 2015 (Reaffirmed Year: 2020), Ordinary Portland Cement – Specification
5. IS: 4031 - 1996 (Reaffirmed Year: 2021) Part1 – Part 15, Methods of physical tests for hydraulic cement
6. IS: 383 – 2016, Coarse and Fine Aggregate for Concrete – Specification
7. IS: 2386 – 1963(Reaffirmed -2021) Part 1 – Part 8, Methods of Test for Aggregates for Concrete
8. 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 Hours	Course Outcome
1.0	**Concrete making Materials**		
1.1	Cement: raw materials and composition	1	CO1
1.2	Hydration chemistry of cement	2	
1.3	Types & grades of cement	1	
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- gradation, bulking of sand, presence of deleterious content, water absorption and moisture content- River sand & M-sand.	2	
1.7	Coarse aggregates – size and shape, gradation, specific gravity, bulk density sieve analysis, water absorption.	2	
1.8	Tests on coarse aggregates - impact, crushing, abrasion attrition and alkali aggregate reaction	2	
1.9	Water and its quality for concreting	1	
2.0	**Concrete Production & Fresh properties**		
2.1	Batching of ingredients, mixing, transporting, and placing	2	CO2
2.2	Compacting, finishing, and curing of concrete	2	
2.3	Fresh concrete properties: Workability, bleeding and segregation of concrete - Factors influencing it	2	
2.4	Tests on workability of concrete	1	
2.5	Chemical Admixtures: Super plasticizers, plasticizers, retarders, accelerators, air entrained admixtures and	2	
2.6	Pozzolanic admixtures	2	
3.0	**Concrete mix proportion**		
3.1	Concept of Mix proportion - Quality acceptance criteria as per IS 456:2000	1	CO3
3.2	Design as per IS-10262:2019	2	
3.3	Design problems	2	
3.4	ACI method (procedures only)	1	
4.0	**Engineering properties of concrete**		
4.1	Compressive strength and parameters affecting it	1	CO4
4.2	Tensile strength - direct and indirect	1	

Module No.	Topic	No. of Hours	Course Outcome
4.3	Modulus of elasticity and Poisson's ratio	1	
4.4	Non-destructive test, partially destructive test	2	
5.0	**Dimensional stability and Durability of concrete**		
5.1	Creep and Shrinkage of concrete	1	CO5
5.2	Chemical attacks of concrete	2	
5.3	Corrosion of steel rebars	1	
5.4	Corrosion preventive measures, alternate reinforcing materials - epoxy coated bars & fibre reinforced plastics	1	
6.0	**Special concretes**		
6.1	Properties and applications of: fibre reinforced concrete and high strength concrete,	2	CO6
6.2	Properties and applications of high-performance concrete and reactive powder concrete	1	
6.3	Properties and applications of lightweight concrete and high-density concrete	1	
6.4	Properties and applications of self-compacting concrete and geo-polymer concrete	1	
6.5	Properties and applicationsof Polymer concrete and its types.	1	
6.6	Properties and applications of Roller compacted concrete and shotcrete	1	
	Total hours	48	

Course Designers:

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22CE570	MATERIALS TESTING LABORATORY

Category	L	T	P	Credit
PCC	0	0	2	1

Preamble

Students of Civil engineering would get exposure in the properties of engineering materials and to identify the behaviour of the given material.

Prerequisite

Fundamentals of Mathematics, strength of materials and Concrete technology.

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Determine the behaviour of structural elements, such as bars, beams and springs subjected to tension, compression, shear, bending and torsion.	TPS3	A+	75
CO2	Determine the physical properties of constituent material of concrete.	TPS3	A+	75
CO3	Determination the properties of fresh concrete.	TPS3	A+	75
CO4	Determine the properties of hardened concrete.	TPS3	A+	75
CO5	Design concrete mixes and apply statistical quality control techniques	TPS3	A+	75
CO6	Explain durability behaviour of concrete	TPS3	A+	75

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

List of Experiments / Activities with CO Mapping

Part A: Strength of Materials Lab. (Any six experiments are to be conducted)

S.No	Description (Cycle 1)	No of Hours	Course Outcome
1	Determination of the Young's Modulus of Steel by conducting tension test in UTM.	2	
2	Determination of the Young's Modulus of the beam (Steel, Wood, Aluminium etc.) by conducting the bending test.	2	
3	Determination of the Young's Modulus of the beam (Steel, Wood, Aluminium etc.) by conducting the bending test using Huggen Berger Tensometer.	2	
4	Determination of the rigidity modulus of the material by conducting torsion test.	2	CO1

5	Determination of the rigidity modulus of the compression and tension spring by conducting spring test.	2	
6	Determination of the Young's Modulus of the beam (Steel, wood, Aluminium etc.) by conducting the deflection test in UTM	2	
7	Determination of Brinell hardness and Rockwell hardness for Steel, Copper, Aluminium and Brass	2	
	Total Hours	**12**	

Part B: Concrete Lab

S.No	Description (cycle 2)	No of Hours	Course outcome
1.	Determination of Consistency and setting time of cement	2	CO2
2.	Determination of Bulk Density, Specific gravity, void ratio of fine and coarse aggregates.	2	
3.	Determination of fineness modulus and grading zone of fine and coarse aggregates.	2	
4.	Determination of Maximum bulk of fine aggregate.	2	
5.	Determination of workability of concrete by slump test	2	CO3
6.	Determination of workability of concrete by compaction factor test	2	
	Total Hours	**12**	

<u>Demonstration Exercises</u>

S.No	Description	Course outcome
1.	Test on hardened concrete (cube compressive strength, split tensile test, flexure test)	CO4
2.	Determination of elastic modulus of concrete.	
3.	Design of concrete by IS method.	CO5
4.	Durability properties of concrete.	CO6

Learning Resources

1. S S Rattan., Strenth of Material, McGraw Hill Educational Private (india)Limited.2011
2. Rajput., Strength of materials, S.Chand publishers, 4th edition, 2006
3. Junnarkar, S.B. & Shah, H.J.., Mechanics of structures, vol.I, II, Charotar Publishing House, India, 1999.
4. A.M.Neville, Properties of concrete, 4th edition,1996.
5. M.S.Shetty , Concrete Technology, AMIE publications,1982

Course Designers:

1. Dr. D. Brindha dbciv@tce.edu
2. Dr. S. Nagan nagan_civil@tce.edu

22CE580	PROJECT PLANNING LABORATORY

Category	L	T	P	Credit
PCC	0	0	2	1

Preamble:

This laboratory course work is intended to provide students with opportunities to acquire knowledge on Planning, Scheduling and Tracking of project.

Prerequisite

Knowledge in Project Management

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Create a Calendar and Work Break Down Structure (WBS) for a project	TPS 3	A	80
CO2	Define activities and relationship. Develop network and its duration	TPS 3	A	80
CO3	Schedule projects and defining resources for activities	TPS 3	A	80
CO4	Analyze and update projects, identify change in critical path and revised duration	TPS 3	A	80
CO5	Balance resource in projects	TPS 3	A	80
CO6	Conduct Earned Value Analysis of projects and Generation of Project Report	TPS 3	A	80

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

List of Experiments/Activities with CO Mapping

Sl No	Description	No of Hours	Course Outcome
1	Creating Calendar & assigning to Project	2	CO1
2	Creating Work Breakdown Structure	2	
3	Developing Network Diagram, Defining Relationship	2	CO2
4	Creating Schedule, Assigning Roles & Resources (Men, Material, Machinery…)	2	CO3
5	Creating Schedule & Resource Allocation and Resource Levelling	2	
6	Creating Schedule & Resource Balancing	2	
7	Updating a project and applying the constraints to the project	2	CO4
8	Project Tracking	2	CO5
9	Calculation of Delay of Project and Planned Value, Earned Value and Actual Cost	2	
10	Calculation of Variance of Each activity and checking whether the project over budget or under budget.	2	CO5
11	Report Generation and exporting in various formats	2	CO6
12	Explore the real time projects with case studies	2	

Learning Resources

1. Kumar Neeraj Jha, "Construction Project Management, Theory and Practice", Pearson Publications, 2018
2. Jerome D. Wiest and Ferdinand K. Levy, "A Management Guide to PERT/CPM", Prentice Hall of India Publishers Ltd., New Delhi, 1994.
3. www.smartpmtraining.com
4. Software Manual

Course Designers:

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2. Mr. B. Dinesh Kumar bdkciv@tce.edu

22CE610	FOUNDATION ENGINEERING

Category	L	T	P	Credit
PCC	3	0	0	3

Preamble

This course offers the theories and methods for accessing the subsurface condition at the construction site, determining the bearing capacity of shallow foundations, load carrying capacity of pile foundations, computing settlement of foundations, earth pressure acting on retaining walls and stability analysis of retaining walls.

Prerequisite

Soil Mechanics

Course Outcomes

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

CO Number	Course Outcome	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Plan detailed subsurface exploration program for determining the geotechnical parameters required for the design of foundations	TPS3	A	65
CO2	Compute bearing capacity of shallow foundations and estimate settlement of footings	TPS3	A	65
CO3	Suggest appropriate shallow foundation and Design their dimensions for equal settlement	TPS3	A	65
CO4	Determine the load carrying capacity of pile foundations and pile groups	TPS3	A	65
CO5	Analyse stability of earthen slopes	TPS2	A	65
CO6	Calculate the lateral earth pressure on retaining walls and check their stability.	TPS3	A	65

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Assessment	**CAT 1**			**CAT 2**			**Terminal exam**			**Assignment 1**			**Assignment 2**		
TPS / **COs**	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	3	12	23	-	-	-	2	-	16	-	-	25	-	-	-
CO2	4	-	33	-	-	-	2	-	18	-	-	45	-	-	-
CO3	5	-	20	-	-	-	2	-	10	-	-	30	-	-	-
CO4	-	-	-	5	-	33	2	-	16	-	-	-	-	-	40
CO5	-	-	-	5	20	-	2	10	-	-	-	-	-	-	15
CO6	-	-	-	4	-	33	2		18	-	-	-	-	-	45

Syllabus

Subsurface Exploration and Site investigation: Objectives of Site Investigation - Stages - Planning - Methods of Site Investigation - Depth and Spacing of bore holes - Penetration Tests (SPT and SCPT) - Disturbed and Undisturbed samples - Sampling techniques - Split Spoon sampler - Thin walled sampler - Stationary Piston sampler - Rock Sampling - RQD - Use of Bore log. **Bearing Capacity and Settlement of Foundation:** Types of Bearing Capacity- Terzaghi's theory and BIS Formula - Factors affecting bearing capacity - Bearing Capacity from insitu tests (SPT and SCPT) - Bearing capacity of Raft Foundation - Types of settlement - Allowable settlement - Determination of settlement of foundations in granular and clay deposit - Codal Provisions - Contact Pressure. **Shallow Foundations:** Functions - Requisites of foundation -Types of shallow foundations - Selection of Foundation based on soil condition -Conventional procedure for proportioning of foundations for equal settlement - Floating foundation – Foundation Drainage. **Deep Foundations:** Consideration leading to selection of pile foundation - Functions and Types of pile foundation - Construction of Piles - Estimating load carrying capacity of piles by Static formula - Dynamic Formulae - Pile Load Test - Negative skin friction in piles - Pile Group - Efficiency and Load Carrying capacity of Pile Group. **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 "Øu=0"analysis.**Lateral Earth Pressure and Retaining Walls:** Types of lateral earth pressure - Rankine's Earth Pressure Theory for cohesive and non-cohesive backfill - Coulomb's earth pressure theory – Culmann's method - Types of retaining walls –Stability analysis of Gravity and Cantilever retaining walls

Text Book

1. Dr.Arora,K.R., "Soil Mechanics and Foundation Engineering", Standard Publishers Distributors, New Delhi,2020.

Reference Books&Web Resources

1. Braja M. Das, "Principles of Foundation Engineering", Eighth Edition, Thomson (India edition),2014.
2. Murthy, V.N.S, "Soil Mechanics and Foundation Engineering", CBS Publishers Distribution Ltd., New Delhi,2015.
3. Gopal Ranjan and Rao, A.S.R., "Basic and Applied Soil Mechanics", New Age International (P) Limited, Publishers New Delhi (India),2013.
4. Donald P. Coduto, "Foundation Design – Principles and Practices", Prentice Hall, New Jersey,2012.
5. NPTEL Materialhttps://nptel.ac.in/courses/105101083/

IS Code of practice:

- IS: 1080(1997) – Design and construction of Shallow Foundations in soils.
- IS: 1888(1997) – Method of load test on soils.
- IS: 1892(1997) – Code of practice for Subsurface investigation for foundations.
- IS:1904(1995)–Design and construction of Foundations in soils. General requirements.
- IS: 2131(1997) – Method for Standard Penetration test for soils.
- IS: 6403(1997) – Code of practice for determination of Bearing capacity of Shallow Foundations.
- IS: 2911 Part 1 Sec. 1(1997) – Design and construction of pile foundations –Driven cast in-situ concrete piles.
- IS:2911Part1Sec.3(1997)–Design and construction of pile foundations – Driven precast concrete piles.
- IS:2911Part3(1980) – Code of practice for Design and construction of pile foundations Under – Reamed piles.
- IS: 2911 Part 4 (2000) – Load Test on Piles.
- IS: 8009 Part 1 (1998) – Code of practice for Calculation of Settlements of Foundations: Shallow Foundations subjected to symmetrical static vertical loads.

Course Contents and Lecture Schedule

Module No.	Topic	No. Of Hours	Course Outcome
1.	**Subsurface Exploration and Site investigation**		
1.1	Objectives of Site Investigation - Stages - Planning	1	CO1
1.2	Methods of Site Investigation - Depth and Spacing of bore holes	2	
1.3	Penetration Tests (SPT and SCPT)	2	
1.4	Disturbed and Undisturbed samples - Sampling techniques - Split Spoon sampler - Thin walled sampler - Stationary Piston sampler	1	
1.5	Rock Sampling - RQD - Use of Bore log	1	
2.	**Bearing Capacity and Settlement of Foundation**		
2.1	Types of Bearing Capacity -Terzaghi's theory and BIS Formula	2	CO2
2.2	Factors affecting bearing capacity - Bearing Capacity from insitu tests (SPT and SCPT)	2	
2.3	Bearing capacity of Raft Foundation -Types of settlement - Allowable settlement	1	
2.4	Determination of settlement of foundations in granular and clay deposit -Codal Provisions - Contact Pressure	2	
3.	**Shallow Foundations**		
3.1	Functions – Requisites of foundation –Types of shallow foundations – Selection of Foundation based on soil condition	2	CO3
3.2	Conventional procedure for proportioning of foundations for equal settlement	2	
3.3	Floating foundation - Foundation Drainage	1	
4.	**Deep Foundations**		
4.1	Consideration leading to selection of pile foundation - Functions and Types of pile foundation - Construction of Piles	2	CO4
4.2	Estimating load carrying capacity of piles by Static formula	2	
4.3	Dynamic Formulae - Pile Load Test	2	
4.4	Negative skin friction in piles - Pile Group - Efficiency and Load Carrying capacity of Pile Group	2	
5.	**Stability of Slopes**		
5.1	Types of slope failures - Different factors of safety -	2	CO5
5.2	Taylor's stability number - Stability analysis by method of slices and "$Ø_u$=0" analysis	2	
6.	**Lateral earth Pressure and Retaining Walls**		
6.1	Types of Lateral Earth pressure - Rankine's Earth Pressure Theory for cohesive and non-cohesive	1	CO6
6.3	Coulomb's earth pressure theory - Culmann's method	2	
6.4	Types of retaining walls – Stability analysis of Gravity and Cantilever retaining walls	2	
	Total Hours	**36**	

Course Designer(s):

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22CE620	DESIGN OF REINFORCED CONCRETE ELEMENTS

Category	L	T	P	Credit
PC	3	0	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.

Prerequisites

22CE530 Concrete Technology

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Explain the design concepts of structural reinforced concrete elements under various forces and interpret IS codal provisions and design the elements under flexure by working stress design method	TPS3	B+	70
CO2	Design the structural reinforced concrete elements under flexure by limit state design method and detail the reinforcement	TPS3	B+	70
CO3	Design the structural reinforced concrete elements under shear, torsion, anchorage and development length by limit state design method and detail the reinforcement	TPS3	B+	70
CO4	Design the structural reinforced concrete elements under compression by limit state design method and detail the reinforcement	TPS3	B+	70
CO5	Check the serviceability requirements of reinforced concrete elements under deflection and cracking	TPS3	B+	70
CO6	Design the foundation by limit state design method and detail the reinforcement	TPS3	B+	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
CO1	4	2	20	-	-	-	-	-	-	-	-	-	2	-	10	-	-	-	-	-	20		-	-	-	-	-	-	-	-
CO2	4	4	30	-	-	-	-	-	-	-	-	-	2	2	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	4	2	30	-	-	-	-	-	-	-	-	-	2	2	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	4	4	30	-	-	-	2	2	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO5	-	-	-	-	-	-	4	-	20	-	-	-	2	-	10	-	-	-	-	-	-	-	-	-	-		20	-	-	-
CO6	-	-	-	-	-	-	4	4	30	-	-	-	2	2	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-

Syllabus

Design Methods: concept of working stress method, ultimate load method and limit state method. Advantages of limit state method over other methods. 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. Design of beams and slabs by working stress method; Development of spreadsheets; Reinforcement detailing. **Limit state of collapse for 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 and flanges sections - simply supported and continuous beams; Design of one way and two way slabs – simply supported, continuous and restrained using coefficients in IS code; Development of spreadsheets; Reinforcement detailing. **Limit state of collapse for shear, torsion, bond and anchorage**: Design of beams for shear and torsion; Design of beams for combined bending, shear and torsion; Design for development length and end anchorages; Reinforcement detailing. **Limit state of collapse for compression**: Braced and unbraced columns; Design of columns for axial load – square, rectangular and circular cross sections with lateral and spiral ties; Design of columns for uniaxial and biaxial eccentricities using interaction charts; Reinforcement detailing. **Limit state of serviceability**: Serviceability requirements for RC elements; 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; Development of spreadsheets; Reinforcement detailing.

Learning Resources

1. N. Subramanian, Design of Reinforced Concrete Structures, Oxford University Press, New Delhi, 2014.
2. Unnikrishna Pillai and Devdas Menon, Reinforced Concrete Design (Fourth Edition), Tata Mc Graw Hill Publishing Company Ltd., New Delhi, 2021.

3. B.C.Punmia, Ashok Kumar Jain and Arun Kumar Jain, Limit State Design of Reinforced Concrete, Laxmi Publications, Revised edition, 2016
4. P.C. Varghese, Limit State Design of Reinforced Concrete, Prentice Hall of India, Pvt. Ltd., New Delhi, 2008.
5. M.L. Gambhir, Fundamentals of Reinforced Concrete Design, Prentice Hall of India Private Limited, New Delhi, Fifth Printing, 2011.
6. N. Krishna Raju and R.N. Pranesh, Reinforced Concrete Design IS 456-2000, Principles and practice, New Age International (P) Ltd Publishers, New Delhi, 2018.
7. S.N. Sinha, Reinforced Concrete Design, Tata McGraw-Hill, New Delhi, 2017.
8. Self-learning materials – Online courses - https://nptel.ac.in/courses/105105105

IS Codes

1. IS 456:2000 Plain and Reinforced Concrete – Code of Practice.
2. IS 875(1-2):1987 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures.
3. IS 875(3):2015 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures
4. IS 875(4-5):1987 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures
5. SP 16:1980 Design Aids for Reinforced Concrete to IS 456:1978.
6. SP 34:1987 Handbook of concrete reinforcement and detailing.
7. Handbook for Limit State Design of Reinforced Concrete Structures – Roorkee.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures	Course Outcome
1.0	**Design Methods**		
1.1	Concept of working stress method, ultimate load method and limit state method, advantages of Limit State Method over other methods 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	1	CO1
1.2	Analysis and design of beams by working stress method	2	CO1
1.3	Design of slabs by working stress method and developing spreadsheets	1	CO1
1.4	Reinforcement detailing	1	CO1
2.0	**Limit state of collapse for flexure**		
2.1	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	1	CO2
2.2	Analysis and design of singly reinforced rectangular sections and developing spreadsheets	1	CO2
2.3	Analysis and design of doubly reinforced rectangular sections	1	CO2
2.4	Design of continuous beams using IS code coefficients	1	CO2
2.5	Analysis of flanged sections	2	CO2
2.6	Design of one way simply supported and continuous slab and developing spreadsheets	1	CO2

2.7	Design of two way simply supported, continuous and restrained slab using coefficients in IS code	2	CO2
2.8	Reinforcement detailing	1	CO2
3. 0	**Limit state of collapse for bond, anchorage, shear and torsion**		
3.1	Design of beams for shear and torsion	1	CO3
3.2	Design of beams for combined bending, shear and torsion	2	CO3
3.3	Design for development length and end anchorages	1	CO3
3.4	Reinforcement detailing	1	CO3
4.0	**Limit state of collapse in compression**		
4.1	Design of columns for axial load – square, rectangular and circular cross sections with lateral	1	CO4
4.2	Design of columns for axial load – circular cross sections with spiral ties	1	CO4
4.3	Design of columns for uniaxial bending using interaction charts	2	CO4
4.4	Design of columns for biaxial bending using interaction charts	2	CO4
4.5	Reinforcement detailing	1	CO4
5. 0	**Limit state of serviceability**		
5.1	Deflection calculations using IS code coefficients – short term and long-term deflection	2	CO5
5.2	Crack width calculations	1	CO5
6. 0	**Design of shallow foundation**		
6.1	Design of isolated square footing and developing spreadsheets	1	CO6
6.2	Design of isolated rectangular footing and developing spreadsheets	1	CO6
6.3	Design of Rectangular combined footing and reinforcement detailing	2	CO6
6.4	Design of Trapezoidal combined footing and reinforcement detailing	2	CO6
	TOTAL	**36**	

Course Designers:

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22CE630	HIGHWAY AND RAILWAY ENGINEERING

Category	L	T	P	Credit
PCC	3	0	0	3

Preamble

The course aims to make the students learn the principles of geometrical design of highways and their components. Further, students will get acquainted with the treatment for failures and remedial measures during maintenance of pavements. This also imparts the student's knowledge of planning, geometrical design, construction and maintenance of railway tracks. The students acquire proficiency in the application of modern techniques such as GIS, GPS and remote sensing.

Prerequisite

Nil

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Understand the basic concepts of highway planning	TPS2	A	70
CO2	Design the geometrical components for Indian roads.	TPS3	A	70
CO3	Gain knowledge on testing procedures of highway material sand construction of different types of roads.	TPS2	A	70
CO4	Understand the basics of railway planning and apply them in design of various railway geometrics.	TPS3	A	70
CO5	Understand the functions of various components of railways, points and crossings.	TPS2	A	70
CO6	Understand the concepts of track maintenance and signaling in railways	TPS2	A	70

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern:

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	4	20		-	-	-	-	-	-	-	-	-	2	-	10	-	-	-	-	-	20		-	-	-	-	-	-	-	-
CO2	4	30		-	-	-	-	-	-	-	-	-	2	2	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3		12	30	-	-	-	-	-	-	-	-	-	2	2	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	4	4	30	-	-	-	2	2	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO5	-	-	-	-	-	-	4	-	20	-	-	-	2	-	10	-	-	-	-	-	-	-	-	-	-		20	-	-	-
CO6	-	-	-	-	-	-	4	4	30	-	-	-	2	2	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-

Syllabus

Highway Planning: Different modes of transportation, Highways-IRC, CRRI and NHAI-Classification of roads-Road patterns-Planning, Surveys-Master Plan and Phasing of master plan- New Highway alignment- Factors, Engineering surveys- Maximum dimension of road vehicles- Passenger Car Units- Pavements- Flexible and rigid components and their functions. Highway drainage - significance- requirements. **Highway Geometric Design:** Various Cross section elements- Friction, roughness, light reflecting characteristics-camber- IRC standards-Right of way- Sight distance- Design of Horizontal Alignments- Super elevation- Widening of pavement on horizontal curves- Transition curves- Types- Length- Problems. Design of vertical alignment- Gradient- Types- Vertical curves- Summit curves, Valley curves- problems. **Highway Materials and Construction:** Materials- Properties of road aggregates and tests-Bituminous materials- Types- Requirements- Tests to determine the properties of Bitumen-Various Bituminous mixes- Highway construction procedures. **Elements of Railway Engineering:** organization of Indian railways and importance of railway in national development - Railway board - Zonal railways, Permanent way - Gauges - Railway Track cross section - coning of wheels - Rails- Rail joints - Creep – effects and remedies - Sleepers - Ballast - Sub grade and Embankment -Track alignment- Surveys. Gradients - super elevation and cant deficiency - Negative super elevation- Curves - points and crossings -necessity - Turnouts - Switches - types of switches and crossing. **Railway Stations and Signals:** Stations and yards - requirements, classification, layout of station and yards - Loco sheds - Derailing switches, Fouling marks, Buffer stop - Sand hump - rolling stock- Signaling - classification and types -Level crossings - Safety in Railways

Learning Resources

1. S.KKhanna,and CEG.Justo and A.Veeraragavan, “Highway Engineering”, New Chand and Bros, Roorkee, Revised 10thedition,2018.
2. Kadiyali,L.R.and N.B.Lal, “Principles and practices of Highway Engineering”, Khanna Publishers, 2018.
3. SaxenaS.C and AroraS.P., “RailwayEngineering”, Dhanpat Rai Publications, 7th Edition, 2011
4. Satish chandra & MM Agarwal., “Railway Engineering”, Oxford University Press, Second Edition,2013

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	Course Outcome
1.0	**Highway Planning**		
1.1	Different modes of transportation, Highways-IRC, CRRI and NHAI-Classification of roads-Road patterns	1	CO1
1.2	Planning Surveys-Master Plan and Phasing of master plan	1	
1.3	New Highway alignment- Factors –Engineering surveys-Maximum dimension of road vehicles- Passenger Car Units	2	
1.4	Pavements- flexible and rigid components and their functions comparison	1	
1.5	Highway drainage- significance- requirements	1	
2.0	**Highway Geometric Design**		
2.1	Various Cross section elements- Friction, roughness, light reflecting characteristics	1	CO2
2.2	camber- IRC standards- Right of way- Sight distance	2	
2.3	Design of Horizontal Alignments- Super elevation-Widening of pavement on horizontal curves	2	
2.4	Transition curves- Types- Length- Problems	2	
2.5	Design of vertical alignment- Gradient- Types- Vertical curves- Summit curves, Valley curves-Problems.	2	
3.0	**Highway Materials and Construction**		
3.1	Materials- Properties of road aggregates and tests	2	CO3
3.2	Bituminous materials- Types- Requirements	2	
3.3	Tests to determine the properties of Bitumen- Various Bituminous mixes- Highway construction procedures	2	
4.0	**Elements of Railway Engineering**		
4.1	Organization of Indian railways and importance of railways in national development - Railway board - Zonal railways	2	CO4
4.2	Permanent way - Gauges - Railway Track cross section - coning of wheels - Rails- Rail joints - Creep – effects and remedies	2	
4.3	Sleepers -Ballast - Sub grade and Embankment -Track alignment- Surveys. Gradients - super elevation and cant deficiency - Negative super elevation - Curves	2	
4.4	Points and crossings -necessity -Turnouts - Switches - types of switches and crossing	2	CO5
5.0	**Railway Stations and Signals**		
5.1	Stations and yards - requirements, classification, layout of station and yards	2	CO5
5.2	Loco sheds - Derailing switches, Fouling marks, Buffer stop - Sand hump - rolling stock	2	
5.3	Signaling - classification and types	2	CO6
5.4	Level crossings - Safety in Railways	2	
	Total Hours	36 Hrs	

Course Designers:

1. Dr. R.Velkennedy rvkciv@tce.edu
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22CE640	ACCOUNTING AND FINANCE

Category	L	T	P	Credit
HSMC	2	1	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 there by 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.

Prerequisite

NIL

Course Outcomes

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

Cos	Course Outcome	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Prepare financial statements of accounting and study them with common size statements and comparative statements.	TPS3	B+	65
CO2	Perform cost sheet, depreciation and its applications in business.	TPS 3	A	75
CO3	Compute various types of budgets in an organization	TPS 3	A	75
CO4	Practice break-even analysis and activity-based costing systems for a business applications.	TPS 3	B+	65
CO5	Compute working capital investment decisions.	TPS 3	B+	65
CO6	Apply the appropriate sources of finance and mobilize the right quantum of finance and use them in most profitable investment avenues.	TPS 2	B+	65

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	4	10	30	-	-	-	-	-	-	-	-	-	2	-	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO2	8	5	15	-	-	-	-	-	-	-	-	-	2	-	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	8	5	15	-	-	-	-	-	-	-	-	-	2	10	-	-	-	-	-	-	20		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	5	30	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO5	-	-	-	-	-	-	5	5	30	-	-	-	2	-	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO6	-	-	-	-	-	-	10	10	-	-	-	-	2	10	-	-	-	-	-	-	-	-	-	-	-		20	-	-	-

Syllabus

Accounting Introduction definition, functions of accounting, accounting principles. Preparation of financial statements and study them with common size and comparative statements. **Cost Accounting** - Meaning and importance - Elements of cost - classification of cost -Cost Centre, Preparation of cost sheet and its applications. Depreciation— meaning and causes of depreciation, Methods to find out the depreciation. **Budget and Budgetary control**-Introduction- Meaning -objectives of budgetary control —Budget-Types of budgets and their preparation. **Marginal costing-**Introduction, Break even analysis—Managerial of break even analysis. Activity based Costing. **Capital budgeting**-Meaning and features, capital budgeting decisions, Methods of evaluating capital budgeting decisions by traditional and modern methods. Working capital management - concept, classification, Estimation of working capital requirements. **Finance**: Functions, Objectives of financial management and Source of finance and financial institutions, Venture capital. Analysis Case Studies: Cost management in the construction industry. (Only for assignment)

Text Book

1. Prasanna Chandra, "Financial Management-Theory and practice" seventh Reprint, Tata McGraw-Hill publishing companyLimited,2019.

Reference Books& web resources

1. M.C.Shukla, T.S.Grewal,"AdvancedAccounts-Volume-I,2010 Reprint, S. Chand & companyLtd.,2010.
2. P.S.Boopathi Manickam "Financial and Management Accounting" PSG publications 2009.
3. Don R.Hansen and Marianne M.Mowen "Cost Management: Accounting and Control, Fifth Edition" Thomson,2006.
4. Michael C. Ehrhardt and Eugene F. Brigham, "Financial Management: Theory and Practice -thirteenth edition" South-Western cengage learning,2011
5. Pandey, "Financial Management", Vikas Publishing House Pvt. Ltd.,2007
6. Paramasivan.C, Subramanian.T, "Financial management" New Age international Publishers,2014.
7. https://nptel.ac.in/courses/110/106/110106135/: Decision makingusing financial accounting, Prof. G Arun Kumar, IIT Madras

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	COs
1.0 Project and its process			
1.1	Introduction, Definition, Functions of accounting	1	CO1
1.2	Accounting principles	1	
1.3	Preparation of Financial statements	3	
1.4	Common size statement analysis	1	
1.5	Comparative statement analysis	1	

2.0 Cost Accounting			
2.1	Meaning, importance and Elements of cost	1	CO2
2.2	classification of cost and meaning of Cost centre,	1	
2.3	Preparation of Cost sheet and its applications	3	
2.4	Depreciation — meaning and causes of depreciation	1	
2.5	Methods to find out the depreciation	2	
3.0 Budget and Budgetary control			
3.1	Introduction- Meaning -objectives of budgetary control	1	CO3
3.2	Budget- Types of budgets and their preparation	4	
4.0 Marginal costing			
4.1	Introduction, Breakeven analysis	2	CO4
4.2	Managerial uses of breakeven analysis.	1	
4.3	Activity Based Costing	2	
5.0 Capital budgeting			
5.1	Meaning and features, capital budgeting decisions	1	CO5
5.2	Methods of evaluating capital budgeting decisions by traditional and modern methods	4	
5.3	Working capital management - concept, classification,	1	
5.4	Estimation of working capital requirements.	1	
6.0Finance			
6.1	Functions and Objectives of Financial Management	1	CO6
6.2	Source of Finance and financial Institution	2	
6.3	Venture Capital	1	
	Total Periods	**36**	

Course Designer(s):

1. Mr. B. Dinesh Kumar bdkciv@tce.edu
2. Mr. G. Ramasamy gryciv@tce.edu

22EG660	PROFESSIONAL COMMUNICATION

Category	L	T	P	Credit
HSMC	0	1	2	2

Preamble

The prime focus of this course is to enhance the employability and career skills of students with an emphasis on grooming them as value-driven professionals. The practice of essential language skills improves their ability to communicate persuasively and ensures their industry-readiness to face real-life challenges.

Prerequisite

Basics of Technical English

Course Outcomes

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

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Demonstrate adequate soft skills relevant for workplace	TPS3	70%	70%
CO2	Listen and respond to native and non-native accented delivery	TPS3	65%	65%
CO3	Interpret general/technical topics in group discussion	TPS3	70%	70%
CO4	Present effectively both in general and technical contexts and interviews	TPS3	70%	70%
CO5	Exhibit verbal aptitude skills through reading and writing	TPS3	70%	70%
CO6	Write error-free business correspondence	TPS3	70%	70%

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Internal Assessment

Students' performance will be continuously assessed in various classroom activities that include Listening, Speaking, Reading and Writing components for 60 marks as detailed below:

Listening Test - 10
Speaking Test (Group Discussion, Mock interview and Technical Presentation) - 30
Reading and Writing Test - 20
Total - 60

End Semester Assessment (LAB):

Listening Test - 20
Group Discussion - 20
Personal Interview / BEC - Vantage speaking Task 2 - 20
General Aptitude Test - 40

Total -100

List of Experiments/Activities with CO Mapping

S.No	Activities	Hours		CO Mapping
		T	P	
1	1.1. Introduction to soft skills 1.2. Hard skills vs soft skills	2		CO1
2	Listening Practice and Test		2	CO2
3	Reading and reasoning practice from Technical passages/articles/dailies	1		CO5
4	1-minute Self-Introduction (based on interview style)	1		CO4
5	GD Techniques	1		CO3
6	GD Practice		3	CO3
7	Interview Techniques	1		CO4
8	Mock interview		3	CO4
9	Presentation skills	1		CO4
10	Technical presentation		3	CO4
11	General Aptitude Practice and test – Vocabulary Development /Sentence completion/Error spotting/Analogy		3	CO5
12	Business Correspondence –BEC - Vantage speaking Task II	1		CO6
13	Basics of Technical Writing	1		CO5
14	Preparation of Resume	1		CO4

Learning Resources

Text Book:

Work book prepared by the Faculty of Dept. of English.

Reference Books:

1. Brooks, Margret. Skills for Success. Listening and Speaking. Level 4 Oxford University Press, Oxford: 2011.
2. Brook-Hart, Guy. Business Benchmark. Upper-intermediate: Student's book, Volume 1. Cambridge University Press: 2013.
3. Patnaik, Priyadarshi. Group Discussion and Interview Skills - Cambridge University Press India; Second edition (1 September 2015).
4. Hughes, Glyn and Josephine Moate. Practical English Classroom. Oxford University Press: Oxford, 2014.

Websites:

1. www.cambridgeenglish.org(BEC-LSRW)
2. www.examenglish.com(OnlineExamsfor international ESL Exams)
3. www.testpreppractice.net(GRETests-Vocabulary/Analogy/SentenceCompletion/Reading)
4. https://www.freshersworld.com(PlacementPapers)

Extensive Reading:

Who Moved My Cheese? - Spencer Johnson, Ebury Publishing, 2002.

Course Designers:

1	Dr. A. Tamilselvi (Convenor)	tamilselvi@tce.edu
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3	Dr. G. Jeya Jeevakani	gjjeng@tce.edu
4	Dr. M. Sarpparaje	mseeng@tce.edu

22CE670	FLUID MECHANICS AND MACHINERY LAB

Category	L	T	P	Credit
PCC	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

22CE330, 22CE430

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Measure the rate of flow in pipe section as well as in open channel sections.	TPS3	A+	80
CO2	Apply the Bernoulli's theorem in real fluid flow problems.	TPS3	A+	80
CO3	Determine experimentally the losses in closed conduits	TPS3	A+	80
CO4	Determine experimentally the performance of hydraulic machines such as turbines and pumps.	TPS3	A+	80

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Students are Examined for 40% in internal and 60% in terminal Examination.

Duration:3 Hours

List of Experiments

S.No	Description	No of Hours	Course Outcome
1.	Determination of coefficient of discharge of small orifice	2	CO1
2.	Flow measurement in pipe using orificemeter	2	
3.	Flow measurement in pipe using venturimeter	2	
4.	Flow measurement in open channel using notches	2	
5.	Verification of Bernoulli's theorem	2	CO2
6.	Determination of frictional loss in pipes	2	CO3
7.	Study of impact of jet on vanes	2	CO4

8.	Performance test on turbines (Pelton wheel, Francis and Kaplan turbine)	4	
9.	Performance test on pumps (Centrifugal, Submersible and Reciprocating pump)	6	
	Total Hours	**24**	

Learning Resources

1. https://fm-nitk.vlabs.ac.in/
2. https://fmc-nitk.vlabs.ac.in/
3. https://eerc03-iiith.vlabs.ac.in/
4. Sarbjit Singh, "Experiments in Fluid Mechanics", PHI Learning Pvt.Ltd, New Delhi, 2^{nd} Edition 2012,

Course Designers:

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

22CE680	ANALYSIS AND DESIGN LABORATORY

Category	L	T	P	Credit
PCC	-	-	2	1

Preamble

This Laboratory is intended to provide students with opportunities to acquire knowledge and to develop skills in Analysis and Design software's. The course shows how to use Analysis and Design softwareto analyse and design 2D and 3D systems. This course also introduces recommended design provisions such as IS456, IS800 and drafting standards for students to use for properly preparing design reports and detail drawings using Analysis and Design software.

Prerequisite

22CE320 - Mechanics of Solids, 22CE420- Structural analysis, 22CE520 - Design of steel elements

Course Outcomes

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

COs	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (Grade)	Expected Attainment Level %
CO1	Model 2D and 3D structures to perform analysis using software.	TPS3	B+	70
CO2	Analyze of statically indeterminate beams for the given loads and Generate an appropriate report.	TPS3	B+	70
CO3	Analyze multistory & multi bayrigid frames for the given loads and Generate an appropriate report.	TPS3	B+	70
CO4	Analyze and design a G+2 RCC frame structure under Dead Load, Live Load and Wind Load and Generate an appropriate report for the given structure.	TPS3	B+	65
CO5	Analyze and design of pitched roof truss for its Dead Load, Live Load and Wind Load and Generate an appropriate report for the given structure.	TPS3	B+	65
CO6	Design of Foundation and Generate an appropriate report and drawings for the given structure.	TPS3	B+	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

List of Experiments/Activities with CO Mapping

Module No.	List of Experiments	No. of Hours	COs
1.	Generate Model of 2D statically Indeterminate beams using various options, Assign the properties, Define of Load and create Load combinations.	**2**	**CO1**
2.	Generate a Model of 2D Frame using various options, Assign the properties, Define of Load and create Load combinations.	**2**	**CO1**
3.	Analysis of 2D beams with Different Load Conditions and Generate analysis reports and diagrams.	**2**	**CO2**
4.	Analysis of 2D frames with Different Load Conditions and Generate analysis reports and diagrams.	**2**	**CO2**
5.	Analyse 3D RCC frame for the given Dead Loads, Live loads including Floor loads & load combinations and Generate analysis reports and diagrams.	**2**	**CO3**
6.	Analyse 3D RCC frame for the given Dead Loads, Live loads, Lateral load & load combinations and Generate analysis reports and diagrams.	**2**	**CO3**
7.	Model G+2 RCC frame for the given plan and Calculate & apply dead load, live load and lateral loads	**2**	**CO4**
8.	Analysis &Design of G+2 RCC frame and Generate Design report and Detail drawing.	**2**	**CO4**
9.	Model pitched roof trussfor the given configuration and Calculate & apply dead load, live load and lateral load	**2**	**CO5**
10.	Analysis &Design of pitched roof trussand Generate Design report and Detail drawing.	**2**	**CO5**
11.	Design of Foundation from the analysis and design output for the given load combinations	**2**	**CO6**
12.	Generate Foundation drawings from the design output	**2**	**CO6**

Learning Resources

1.www.connect.bentley.com
2. Bentley communities.

Course Designers

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2. Ms. G. Celine Reena celinereena@tce.edu

22CE710	CONSTRUCTION MANAGEMENT

Category	L	T	P	Credit
PCC	2	0	0	2

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

COs	Course Outcome	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Enumerate the objectives and principles of construction management	TPS2	B+	70
CO2	Discuss the components involved in planning of resources for construction projects	TPS3	B+	70
CO3	Enumerate tendering and contractual procedure and systems of execution of construction works	TPS3	B+	70
CO4	Explain the process involved in measurement of construction works and preparation of accounts	TPS3	B+	70
CO5	Specify the process involved in maintenance and management of stores in construction projects	TPS2	B+	70
CO6	Classify wastes in construction sites, apply lean principles and tools to minimize waste and maximize value	TPS3	B+	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	5	-	-	-	-	-	-	-	-	-	-	2	10	-	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO2	5	10	30	-	-	-	-	-	-	-	-	-	2	-	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	-	5	40	-	-	-	-	-	-	-	-	-	2	-	20	-	-	-	-	-	20		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	10	20	-	-	-	2	-	15	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-
CO5	-	-	-	-	-	-	5	20	-	-	-	-	2	10	-	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-
CO6	-	-	-	-	-	-	-	10	30	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-

Syllabus

Construction Management – General Principles – need, objectives and functions, Classification and stages involved in construction projects – Construction team - **Preliminary planning of a scheme – Construction planning**. **Tendering and contractual procedures** - definition of tender and contract. Deposits – Earnest Money Deposit and Security Deposit – legal implications –– Penalties and Arbitration- **Execution of works**: Methods - Departmental labour- Muster Roll system and Casual Labour system. EPC and other forms of contracts. **Measurement of Works**–M-book, Types of measurements – original, pre and check measurement. Maintenance of Accounts –-Types of bills and payment – completion reports and completion certificates. **Stores**: Classification and Codification systems - inspection and maintenance – Stock verification procedures. **Concept of Lean**: Classify wastes in construction sites, apply lean principles and tools to minimize waste and maximize value.

Text Book

Reference Books& web resources

1. Kumar Neeraj Jha, "Construction Project Management", Pearson Publication, 2018
2. S. Sangareddi and P.L. Meiyappan, "Construction Management", Kumaran Publications, Coimbatore, 2000
3. B.C. Punmia and K.K. Khandelwal, "Project Planning and Control with PERT/CPM", Laxmi publications, New Delhi, 2000
4. B.L. Gupta and Amit Gupta, "Construction Planning and Accounts", Standard Publishers Distributors, Delhi, 1997
5. P.S. Gahlot and B.M. Dhir, "Construction Planning and Management", New Age International Limited, Publishers, 1996
6. V.N. Vazirani and S.P. Chandola, "Construction Management and Accounts", Khanna Publishers, New Delhi, 1986
7. https://online.hbs.edu/courses/management-essentials/
8. https://www.coursera.org/specializations/construction-management
9. https://www.udemy.com/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Construction Management**		
1.1	General Principles –need, objectives and functions, Classification and stages involved in construction projects	1	CO1
1.2	Types of construction, Construction team – Administrative Approval, Technical Sanction and Budget provision	2	
2.0	**Planning of Projects**		
2.1	Preliminary planning of a scheme – influencing factors	1	CO2
2.2	Materials, equipment and labour management	1	
3.	**Tendering and contractual procedures**		
3.1	Definition of tender –Tendering procedure – Tender document	1	CO3
3.2	Definition of contract- legal implications, contract document	1	
3.3	Penalties and Arbitration-procedure	1	
3.4	Execution methods: Departmental labour- Muster Roll system and Casual Labour system	2	
3.5	Various forms of contracts-merits and demerits	2	
4	**Measurement of Works**		
4.1	M-book, Types of measurements – original, pre and check measurements	1	

4.2	Maintenance of Accounts–Types of bills and payment –completion reports and completion certificates	2	CO4
5.0	**Stores**		
5.1	Definition of stores-Classification and Codification systems	2	CO5
5.2	Maintenance of stock and tool and plant accounts	2	
5.3	Inspection and maintenance – Stock verification procedures	1	
6.0	**Concept of Lean**		
6.1	Lean – need and concept. Identification of wastes in project sites	2	CO6
6.2	Lean principles – concept		
6.3	Lean tools – LPS, VSM, 5S etc and application to minimize wastes in projects	2	
		TotalHours	**24**

Course Designer(s):

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22CE720	IRRIGATION AND WATER RESOURCES ENGINEERING

Category	L	T	P	Credit
PCC	3	0	0	3

Preamble

This subject deals with study of water resources potential and various irrigation methods practiced in our country and also to understand an irrigation system and its components.

Prerequisite

Nil

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Outline the importance and status of water resources potential of our country and water policy.	TPS2	A	75
CO2	Illustrate the different types and methods of irrigation practices.	TPS3	A	75
CO3	Compute the storage capacity of reservoir and the forces acting on dam.	TPS3	A	75
CO4	Describe the functions of each components of Diversion headwork.	TPS3	A	75
CO5	Identify the location of Cross Drainage Works and design the canal.	TPS3	A	75
CO6	Describe the components of tank irrigation and the concept of irrigation management transfer.	TPS2	A	75

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern:

CO	CAT1			CAT2			Terminal			Assignment 1			Assignment 2		
TPS Scale	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	5	15	-	-	-	-	2	5	-	-	-	-	-	-	-
CO2	5	10	25	-	-	-	4	-	15	-	-	50	-	-	-
CO3	5	10	25	-	-	-	4	10	10	-	-	50	-	-	-
CO4	-	-	-	5	10	25	4	10	10	-	-	-	-		50
CO5	-	-	-	5	15	25	4	-	15	-	-	-	-		50
CO6	-	-	-	5	10	-	2	5	-	-	-	-	-		-

Syllabus

Importance of Water Resources: Status of water resource potential of India and Tamilnadu-Requirement of water for various uses - Need for water conservation-Water harvesting techniques-National water policy-Benefits of linking of rivers. Impact of climate change on Water resources. **Irrigation:** Need for irrigation-Advantages and ill effects of irrigation-Types and methods of irrigation-Lift and rain fed irrigation-Soil, Water and Plant relationship - Irrigation Efficiencies-Irrigation water quality-Duty and Delta. **Reservoir Planning:** Site selection for reservoir-Classification of reservoirs-Determination of storage capacity-Reservoir sedimentation -Methods of sediment control. **Dams:** Classifications of dams-Forces acting on gravity dam-Failures and remedies of gravity dam-Elementary and practical profile of gravity dam- Type of spillways. **Diversion Headwork:** Components and functions of Diversion headwork -Types, failures and remedies of weir-Design of impervious floor of weir by Bligh's theory and Lane's weighted creep theory-River training works. **Canals and Cross Drainage Works:** Classification of canals - Alignment of canal **-** Design of canal by Lacey's theory and Kennedy's theory-Need, location and types of canal falls-Water logging, causes and effects-Canal lining and canal maintenance-Types of cross drainage works. **Irrigation Water Management:** Tank irrigation -Components of tank irrigation-Water user association-Automation of irrigation systems-Software in water resources.

Learning Resources

1. Santhosh Kumar Garg, "Irrigation Engineering and Hydraulic Structures" Khanna Publishers-New Delhi. 2017
2. Punmia, B.C and Pande B.B Lal, "Irrigation and Water Power Engineering", Lakshmi Publications (P) Ltd, New Delhi. 2016
3. Sharma R.K and Sharma T.K' "Irrigation Engineering (Including Hydrology)", S.Chand& Co Ltd, New Delhi. 2014
4. Dilip Kumar Mujumdar, "Irrigation Water Management-Principles & Practice", Prentice Hall of India (P) Ltd, New Delhi. 2015
5. National Water Policy 2012, MOWR,GOI

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Importance of Water Resources**		CO1
1.1	Status of water resources in India and Tamilnadu.	1	
1.2	Requirement of water for various uses-Needs for water conservation, water harvesting techniques.	1	
1.3	Salient points of National Water Policy and linking of rivers	1	
1.4	Impact of climate change on water resources	1	
2.	**Irrigation**		CO2
2.1	Need, advantages and ill effects of irrigation.	1	
2.2	Types and methods of irrigation, lift and rain fed irrigation, modern irrigation practices.	2	
2.3	Soil Water Plant relationship.	1	
2.4	Irrigation efficiencies, Irrigation water quality.	1	
2.5	Duty and Delta, methods of improving duty.	1	
3.	**Reservoir Planning and Dams**		CO3
3.1	Classification of reservoirs, Surveys conducted, Site selection for reservoir	1	

3.2	Storage zones, determination of Storage capacity of reservoir	1	
3.3	Reservoir sedimentation, methods of controlling the sedimentation,	1	
3.4	Classifications of dams, selection of dams.	1	
3.5	Forces acting on gravity dam.	1	
3.6	Failures and remedies of gravity dam.	1	
3.7	Elementary and practical profile of gravity dam, Drainage galleries in dams.	1	
3.8	Types of spillways.	1	
4	**Diversion Headwork**		CO4
4.1	Components of diversion headwork and its functions	2	
4.2	Types, failures and remedies of weir	2	
4.3	Design of impervious floor of weir by Bligh's theory and Lanes weighted creep theory.	2	
4.4	River training works.	2	
5	**Canals and Cross drainage works**		CO5
5.1	Classification and alignment of canal	1	
5.2	Design of canal by Kennedy's theory.	2	
5.3	Design of canal by Lacey's theory	1	
5.4	Need, location and types of canal falls.	1	
5.5	Water logging, causes and effects, Canal lining and Canal maintenance.	1	
5.6	Functions of Aqueduct, Syphon aqueduct, Level crossing, inlet and outlet, Canal outlets.	1	
6.	**Irrigation Water Management**		CO6
6.1	Tank irrigation-Components of tank irrigation.	1	
6.2	Functions of water user association.	1	
6.3	Automation and sensors in irrigation systems-Software in water resources.	1	
	Total hours	**36**	

Course Designers:

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22CE760	ESTIMATION AND COSTING LABORATORY

Category	L	T	P	Credit
PCC	0	0	2	1

Preamble:

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

Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Explain the detailed specifications of various activities in construction works	TPS 3	A	80
CO2	Estimate quantities of items of works for residential buildings of load bearing type - Individual wall method	TPS 3	A	80
CO3	Estimate quantities of items of works for residential buildings of load bearing type - Centre line method	TPS 3	A	80
CO4	Estimate quantities of items of works for residential buildings of framed type	TPS 3	A	80
CO5	Estimate quantities of earthwork in cutting and embankment for road work	TPS 3	A	80
CO6	Conduct rate analysis for various activities involved in construction works	TPS 3	A	80

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

List of Experiments/Activities with CO Mapping

Sl No	Description	No of Hours	Course Outcome
1	Framing detailed specifications for various activities involved in construction works	2	CO1
2	Preparation of Preliminary estimate of buildings	2	
3	Estimate quantities of items of works for residential buildings of load bearing type using Individual wall method	3	CO2
4	Estimate quantities of items of works for residential buildings of load bearing type using Centre line method	3	CO3

5	Estimate quantities of items of works for residential buildings of framed type	3	CO4
6	Estimate quantities of earthwork in embankment for road work	2	CO5
7	Estimate quantities of earthwork in cutting and embankment for road work	4	
8	Rate analysis – concept and terminologies, CPWD- DSR/ PWD Schedule of rates	1	CO6
9	Arriving at rate per unit of items of plain concrete in different types of foundation, floor and weathering course work	1	
10	Arriving at rate per unit of items of different types of RCC works in structural elements – Beams, Columns, slabs etc.	1	
11	Arriving at rate per unit of items of different types of Masonry works (Stone, Brick etc.), reinforced brick work.	1	
12	Arriving at rate per unit of items of different types of finishing works – plastering, flooring, DPC, pointing, painting etc.	1	
	Total	**24**	

Learning Resources

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
3. Robert Peurifoy and Gerold Oberlender "Estimating Construction Costs", Kindle Edi, 2011
4. Govt of Tamil Nadu PWD – "Standard Schedule of Rates", latest
5. CPWD –DSR: https://cpwd.gov.in › Publication › DSR_Vol_2_2018
6. https://www.coursera.org/learn/construction-cost-estimating

Course Designers:

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22CE770	ENVIRONMENTAL ENGINEERING LABORATORY

Category	L	T	P	Credit
PCC	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

Water supply Engineering, Wastewater Engineering

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment level
CO1	Determine the chemical characteristics of Water from different sources.	TPS3	A+	90
CO2	Determine the chemical characteristics of Wastewater generated from the community.	TPS3	A+	90
CO3	Calculate the necessary dosage of coagulant and disinfectant for the effective removal of turbidity and pathogens from water/wastewater.	TPS3	A+	90
CO4	Measure the ambient air quality parameters such as Particulate Matter, NO_x and SO_X.	TPS3	A+	90
CO5	Physically Characterize the municipal solid waste.	TPS3	A+	90
CO6	Assess the noise level in an area.	TPS3	A+	90

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

List of Experiments/Activities with CO Mapping

S.No	Description	No of Hours	Course Outcome
1.	Determination of Fluorides and Nitrates in drinking water – Spectro photometric analysis.	2	CO1
2.	Determination of Sulphate in water sample – Turbiditymetric analysis.	2	CO1
3.	Determination of Dissolved oxygen in drinking water.	2	CO1
4	Determination of sodium and potassium in water sample using Flame Photometer	2	CO1

5	Determination of Total solids, suspended solids, Dissolved solids, Organic solids, Inorganic solids in water and wastewater samples.	2	CO2
6	Determination of BOD and COD of wastewater	2	CO2
7	Determination of Oil and greasy matters in wastewater samples.	2	CO2
8	Optimum coagulant dosage for removal of turbidity in water.	2	CO3
9	Estimation of chlorine dosage for disinfection of water.	2	CO3
10	Measurement of Ambient air quality parameters – Particulate Matter, SO_2, NOx	2	CO4
11	Physical characterization of municipal solid waste	2	CO5
12	Measurement of a sound pressure level in a working area using a sound level meter	2	CO6
	Total Hours	**24**	

Demonstration Experiments:

1. Heavy metal measurement using AAS.

Learning Resources

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 CODE:

1. IS 3025 : Part 34 : 1988 Methods of sampling and test (Physical and Chemical) for water and wastewater : Nitrate
2. IS 3025 : Part 24 : 1986 Methods of sampling and test (Physical and Chemical) for water and wastewater : Sulphate
3. IS 3025 : Part 60 : 2008 Methods of sampling and test (Physical and Chemical) for water and wastewater : Fluoride
4. IS 3025 : Part 10 : 1984 Methods of sampling and test (Physical and Chemical) for water and wastewater : Turbidity
5. IS 3025 : Part 45 : 1993 Methods of sampling and test (Physical and Chemical) for water and wastewater : Sodium and Potassium
6. IS 3025 : Part 16 : 1984 Methods of sampling and test (Physical and Chemical) for water and wastewater : FILTERABLE RESIDUE (TOTAL DISSOLVED SOLIDS)
7. IS 3025 : Part 44 : 1993 Methods of sampling and test (Physical and Chemical) for water and wastewater : BIOCHEMICAL OXYGEN DEMAND (BOD)
8. IS 3025 : Part 39 : 1989 Methods of sampling and test (Physical and Chemical) for water and wastewater : Oil and Grease
9. IS 3025 : Part 58 : 2006 Methods of sampling and test (Physical and Chemical) for water and wastewater : CHEMICAL OXYGEN DEMAND (COD)
10. IS 3025 : Part 31 : 1988 Methods of sampling and test (Physical and Chemical) for water and wastewater : Phosphorous
11. IS 15575-1 (2005): Electroacoustics - Sound level meters, Part 1 Specification.
12. IS 5182 : Part 2 : 2001 Methods for Measurement of Air Pollution : Sulphur dioxide
13. IS 5182 : Part 6 : 2006 Methods for Measurement of Air Pollution : Oxides of Nitrogen
14. IS 5182 : Part 23: 2001 Methods for measurement of air pollution: Respirable Suspended Particulate Matter (PM10) cyclonic flow techniques.

Course Designers

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22CE780	SOIL AND HIGHWAY ENGINEERING LABORATORY

Category	L	T	P	Credit
PCC	0	0	2	1

Preamble

This laboratory course is intended to give hands-on training to determine various index and engineering properties of soil, compaction characteristics, predict the properties of aggregates and sub grade material. With these properties, students will be able to identify, classify and appreciate the use of soil and aggregates as suitable construction materials, design appropriate foundations and pavements.

Prerequisites

Soil Mechanics

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level%
CO1	Conduct tests to determine index properties of soil such as Moisture Content, Specific Gravity and Atterberg's Limits	TPS3	A+	75
CO2	Conduct tests to determine Field Density and Particle Size Distribution of soil	TPS3	A+	75
CO3	Determine the Coefficient of Permeability of soil	TPS3	A+	75
CO4	Estimate the Shear Strength parameters of Cohesionless and Cohesive soils	TPS3	A+	75
CO5	Predict the Compaction& consolidation characteristics of soil and evaluate the Strength of Sub Grade material	TPS3	A+	75
CO6	Perform tests for accessing the suitability of bitumen and aggregates in Highway and Railway works	TPS3	A+	75

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

List of Experiments/Activities with CO Mapping

S. No	Description	No. of hours	Course Outcome
1	a. Determination of Specific Gravity of soil using Pycnometer. b. Determination of Water Absorption and Specific Gravity of Aggregates (size > 40mm). c. Determination of Penetration value of Bitumen.	2	CO1, CO6
2	(a) Determination of Moisture Content of soil by Oven Drying method (b) Determination of Shrinkage Factors of soil. (c) Determination of Softening Point of Bitumen.	2	CO1, CO6
3	Determination of Liquid and Plastic Limits of soil.	2	CO1
4	Grain size Distribution Analysis for soil.	2	CO2
5	Determination of Field Density of soil by sand Replacement Method.	2	CO2
6	Determination of Coefficient of Permeability of soil by Constant Head Permeability Test.	2	CO3
7	Determination of Coefficient of Permeability of soil by Variable Head Permeability Test.	4	CO3
8	Determination of Shear Strength parameters of soil by Direct Shear Test.	2	CO4
9	(a) Determination of Unconfined Compressive Strength of clay. (b) Determination of Consolidation Properties of soil.	2	CO4, CO5
10	Determination of Dry Density - Moisture Content relation using Light Compaction (Standard Proctor Compaction Test).	2	CO5
11	Determination of California Bearing Ratio value of sub grade soil.	2	CO5
12	(a) Determination of Impact Value of aggregates. (b) Determination of Flakiness and Elongation Indices of aggregates.	2	CO6
	Total Hours	**24**	

Demonstration Experiments:

1. Grain Size Distribution - Hydrometer Analysis
2. Determination of Los Angeles Abrasion value of aggregates.

Learning Resources

1. “Soil and Roads Lab Manual”, Department of Civil Engineering, TCE.
2. Dr.Arora, K. R., “Soil Mechanics and Foundation Engineering”, Standard Publishers Distributors, New Delhi,2015.
3. S.K.Khanna, and CEG.JustoandA.Veeraragavan,“Highway Engineering”, NewChand and Bros, Roorkee, 10th edition,2015.

IS Code of Practice:

- 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-Part7-1983,"DeterminationofWatercontent-DrydensityRelationusinglight 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:2386Part1-1963,"MethodsofTestforAggregatesforConcrete"(PartI-ParticleSize and Shape)
- 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-1203 -1978 “Methods for testing of Tar”-“Penetration Value of Bitumen”

Course Designers

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22CEPA0	FINITE ELEMENT ANALYSIS

Category	L	T	P	Credit
PSE	2	1	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, resolution of forces and equilibrium concepts.

Course Outcomes

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

COs	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level%
CO1	Execute the potential energy concepts, equations of equilibrium weak and variational formulation	TPS3	A	70
CO2	Resolve the stresses and reaction forces in one dimensions	TPS3	A	70
CO3	Resolve the stresses and forces in trusses	TPS3	A	70
CO4	Resolve two dimensional problems using constant strain triangle Elements	TPS3	A	70
CO5	Execute is parametric formulation for two dimensional problems	TPS2	A	75
CO6	Resolve the Gaussian quadrature of one- and two-dimensional integrals	TPS3	A	70

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
CO1	5	10	15	-	-	-	-	-	-	-	-	-	1	-	10	-	-	-	-	-	20		-	-	-	-	-	-	-	-
CO2	5	-	30	-	-	-	-	-	-	-	-	-	2	-	17.5	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	5	-	30	-	-	-	-	-	-	-	-	-	2	-	17.5	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	-	30	-	-	-	2	-	17.5	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO5	-	-	-	-	-	-	5	25	-	-	-	-	2	10	-	-	-	-	-	-	-	-	-	-	-		20	-	-	-
CO6	-	-	-	-	-	-	5	-	30	-	-	-	1	-	17.5	-	-	-	-	-	-	-	-	-	-		40	-	-	-

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 modelling – 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 modelling – constant strain triangle – problem modelling and boundary conditions - stress calculations. **Two dimensional Isoparametric elements:** Isoparametric elements - four node quadrilateral elements - Stress-strain relationship - Nine node quadrilateral elements-Higher order elements. **Numerical Integration:** One point formula and two point formula – two dimensional integrals.

Learning Resources

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
4. David V. Hutton “Fundamentals of Finite Element Analysis 1st Edition” Tata McGraw Hill Publishing Co.Ltd. New Delhi 2003.
5. Moaveni,S., Finite Element Analysis : Theory and Application with ANSYS, Prentice Hall Inc., 1999.
6. G. Ramamurty, “Applied Finite Element Analysis” I. K. International publishing house Pvt Ltd. 2010.
7. Zienkiewicz, O.C, and Taylor, R.L., The Finite Elements Methods , Mc Graw Hill , 6th edition 1987.
8. Singiresu S. Rao, Singiresu S. RAO “The Finite Element Method in Engineering” Elsevier Butterworth-Heinemann 2005
9. http://nptel.ac.in/courses/112104116/
10. http://nptel.ac.in/courses/105106051/
11. http://nptel.ac.in/courses/112104115/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**Fundamental Concepts**		
1.1	Introduction- Stresses and equilibrium	1	CO1
1.2	Boundary conditions	1	CO1
1.3	Strain-displacement relations, Stress – strain relations – potential energy and equilibrium	1	CO1
1.4	Weighted Integral and Weak formulation	1	CO1
1.5	Variational Approach- Rayleigh Ritz method- Galerkin method	1	CO1
	Tutorial- Variational Approach and Weak formulation	2	CO1
2	**One dimensional formulation**		
2.1	Introduction – Finite Element Modelling, coordinates and shape functions	1	CO2
2.2	Assembly of Global Stiffness Matrix and Load Vector-Properties of K, finite element equations and treatment of boundary conditions	2	CO2
2.3	Quadratic shape functions, temperature effects	1	CO2
	Tutorial - One dimensional problems	2	CO2
3	**Trusses**		
3.1	Introduction – Plane trusses	1	CO3
3.2	Local and global coordinate systems	1	CO3
3.3	Element stiffness matrix	1	CO3
3.4	Stress calculations for truss elements	1	CO3
	Tutorial - Truss problems	2	CO3
4	**Two dimensional formulation**		
4.1	Introduction of two dimensional problems- Constant strain triangle	1	CO4
4.2	Constant strain triangle- Element stiffness matrix	1	CO4
4.3	Constant strain triangle- force matrix	1	CO4
4.4	Constant strain triangle- stress calculation	1	CO4
	Tutorial – two dimensional problems	2	CO4
5	**Two dimensional Isoparametric elements**		
5.1	Introduction - Isoparametric elements	1	CO5
5.2	Four node quadrilateral elements - Element strain-displacement matrix - Element stiffness matrix	2	CO5
5.3	Nine node quadrilateral elements - Shape functions - Higher order elements	2	CO5
6	**Numerical Integration**		
6.1	Gauss quadrature - One point formula- two point formula	1	CO6
	Tutorial - One point formula- two point formula	2	CO6
6.2	Two dimensional integrals	1	CO6
	Tutorial – Two dimensional integrals	2	CO6
	Total Hours	**36**	

Course Designers:

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22CEPB0	DYNAMICS OF STRUCTURES AND EARTHQUAKE ENGINEERING

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

This course deals with the dynamic analysis of single and multi-degree freedom systems. It covers the dynamic response of a single-degree-of-freedom system with damping subjected to harmonic excitation and its solving techniques and the response of linear multi-degree-of-freedom systems regarding natural frequencies and mode shapes. This course also offers to introduce the EQ phenomenon, including the causes, occurrence, seismic hazard analysis and its effect on the built structures and explains the aspects of the earthquake-resistant design of RC Structures and shear walls.

Prerequisite

Structural Analysis

Course Outcomes

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

COs	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level%
CO1	Establish the equation of motion and determine the response of a single Degree of freedom system under free vibration with or without damping logarithmic decrement.	TPS3	B	70
CO2	Perform Eigenvalue analysis of multi Degree of Freedom system with DoFs upto three and earthquake excitation	TPS3	B	70
CO3	understand the seismology, causes of an earthquake and effects of ground motion	TPS2	B	75
CO4	Understand how Seismic Hazard analysis helps to obtain Ground motion parameters and evaluate liquefaction potential	TPS2	B	75
CO5	Exercise the procedure for seismic analysis of RC buildings as per IS1893:2016 code provisions and apply the principles of ductile detailing in reinforced concrete structures as per IS 4326 and IS 13920	TPS3	B	70
CO6	Demonstrate the behaviour and Design of Shear wall	TPS3	B	70

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

CO	CAT1			CAT2			Terminal			Assignment 1			Assignment 2		
TPS Scale	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1	5	-	35	-	-	-	2	-	16	-	-	40	-	-	-
CO2	5	-	35	-	-	-	2	-	16	-	-	40	-	-	-
CO3	5	15	-	-	-	-	2	12	-	-	20	-	-	-	-
CO4	-	-	-	5	15	-	2	12	-	-	-	-	-	20	-
CO5	-	-	-	5	-	35	2	-	16	-	-	-	-	-	40
CO6	-	-	-	5	-	35	2	-	16	-	-	-	-		40

Syllabus

Introduction to vibration and damping, Single degree of freedom system - mass-spring-damper system- **Free vibration-** Formation of the equation of motion and the response of undamped and damped system - Determination of damping using logarithmic decrement method. **Forced vibration-** Response of single degree of freedom system to harmonic and periodic excitation of undamped and damped system. **Multi-degree freedom system:** formulation of the equation of motion for two and three degree of freedom systems – Perform Eigenvalue analysis - finding mode shapes and natural frequencies for free vibrations, damping in structures Dynamic analysis and the response of the linear system. **Seismology** Introduction – Seismic waves - Earthquake magnitude, the intensity of an earthquake, the epicentre – Plate tectonics -Seismic Energy –EQ resistance in masonry building – Short column effect –Soft Storey - Centre of stiffness – Centre of mass –Potential deficiencies of RC building and masonry building – Remedial measures for earthquake resistant buildings - **Seismic Hazard Analysis** Moment magnitude -Deterministic Seismic Hazard Analysis (DSHA**)-** Evaluation of liquefaction potential as per IS 1893:2016 (Part-1) **Design methodology** Planning considerations / Architectural concepts as per IS:4326 – 1993 – Guidelines for Earthquake resistant design – Lateral load analysis – Equivalent Static analysis -Response spectrum method as per IS 1893:2016 (Part-1) -Lateral force evaluation in masonry buildings **Shear wall**- Types of shear walls- Design of shear wall as per IS1893 and details as per IS:13920 – 2008.

Learning Resources

1. Anil K.Chopra, “Dynamics of Structures: Theory and Applications to Earthquake Engineering”, Prentice Hall, Englewood Cliffs, New Jersy, Second Edition, 2012.
2. Clough, R.W. and Penzien,J., “ Dynamics of Structure”,McGraw-Hill,inc.,New York 2003.
3. Mario Paz, “Structural Dynamics: Theory and Computation”, CBS Publications, New Delhi, 2004.
4. Berg. Glen v., “Elements of Structure Dynamics” ‘Prentice Hall Englewood Cliffs, New Jersy.1989.
5. Cheng, F.Y., “Matrix Analysis of Structure Dynamics”, Marcel Dekker, New York, 2001.
6. Manicka Selvam K., “Elementary Structural Dynamics”, Dhanpatrai and sons, New Delhi,2001.
7. Hurty.W.C, Rubinstein.M.F,”Dynamic of Structure”, Prentice Hall of India Pvt Ltd.New Delhi.
8. Pankaj Agarwal and Manish Shrikhande, “Earthquake Resistant Design of Structures”, Prentice Hall of India, New Delhi, 2009
9. Mohiuddin Ali Khan, “Earthquake Resistant Structures: Design, Build and Retrofit”, Elsevier Science & Technology, 2012
10. . S.K. Duggal, “Earthquake Resistant Design of Structures”, Oxford University Press, New Delhi, 2007.
11. IS 1893 (Part-1):2016- Criteria for Earthquake resistant design of structures
12. IS 13920:2008-Ductile detailing of Reinforced Concrete Structures subjected to Seismic Forces-Code of Practice

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction to vibration and damping**		
1.1	Single degree of freedom system, mass-spring-damper system	1	CO1
	Free Vibration		
1.2	Formation of the equation of motion and response of undamped SDOF system	1	CO1
1.3	Formation of equation of motion of SDOF and its response damped system	1	CO1
1.4	Delay in motion. Determination of damping using logarithmic decrement method.	1	CO1
1.5	Response of single degree of freedom undamped and damped system to harmonic excitation	1	CO1
1.6	Response of single degree of freedom undamped and damped system to periodic excitation	1	CO1
2	**Multi degree of freedom system:**		
2.1	Formulation of equation of motion for two and three degree of freedom systems with or without damping	1	CO2
2.2	Formulation of equation of motion for two and three degree of freedom systems with damping	2	CO2
2.3	Perform Eigenvalue analysis of two and three degree freedom system	2	CO2
2.3	Finding mode shapes and natural frequencies for free vibrations	2	CO2
2.4	Dynamic analysis and response of linear system.	1	CO2
3.	**Seismology**		
3.1	Seismic waves - Earthquake magnitude, intensity of earthquake	1	CO3
3.2	Potential deficiencies of RC building and masonry building	3	CO3
3.3	Short column effect –Soft Storey and weak storey	1	CO3
3.4	Remedial measures for earthquake resistant buildings	2	CO3
4.	**Seismic Hazard Analysis**		
4.1	Deterministic Seismic Hazard Analysis (DSHA)	2	CO4
4.2	Moment magnitude ,Attenuation Relationship	2	CO4
4.3	Seismic Hazard Curves	1	CO4
4.4	Evaluation of liquefaction potential as per IS 1893:2016 (Part-1)	3	
5.	**Design methodology**		
5.1	Planning considerations / Architectural concepts as per IS:4326 – 1993	1	CO5
5.2	Equivalent Static analysis - Response spectrum method as per IS 1893:2016 (Part-1)	2	CO5
5.3	Lateral force evaluation in masonry buildings	1	CO5
6.	**Shear wall**		
6.1	Necessity of shear wall and Introduction	1	CO6
6.2	Types of shear wall	1	CO6
6.3	Design of shear wall as per IS:1893-2016(Part-1) and details as per IS:13920 – 2008.	2	CO6

Course Designers:

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22CEPC0	PRESTRESSED CONCRETE

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

Prestressed concrete is extensively used 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.

Prerequisite

22CE620 Design of Reinforced Concrete Elements

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level%
CO1	Describe the systems and methods of prestressing and its analysis	TPS3	B	70
CO2	Determine the losses of prestress and deflection of prestressed concrete beams	TPS3	B	70
CO3	Analyse and design the prestressed concrete beams and slabs under various forces	TPS3	B	70
CO4	Analyse the prestressed concrete continuous beams	TPS3	B	70
CO5	Analyse and design the circular prestressed concrete members	TPS3	B	70
CO6	Analyse the composite prestressed concrete members	TPS3	B	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	4	2	20	-	-	-	-	-	-	-	-	-	2	-	10	-	-	-	-	-	20		-	-	-	-	-	-	-	-
CO2	4	4	30	-	-	-	-	-	-	-	-	-	2	2	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	4	2	30	-	-	-	-	-	-	-	-	-	2	2	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	4	4	30	-	-	-	2	2	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO5	-	-	-	-	-	-	4	2	30	-	-	-	2	-	15	-	-	-	-	-	-	-	-	-	-		30	-	-	-
CO6	-	-	-	-	-	-	4	2	20	-	-	-	2	2	10	-	-	-	-	-	-	-	-	-	-		30	-	-	-

Syllabus

Systems of prestressing and its analysis: Basic concepts of prestressing, need for high strength steel and concrete, advantages, applications, pre-tensioning and post-tensioning systems, partial prestressing; Analysis of prestress **-**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 and Deflection of PSC members:** Loss due to elastic deformation of concrete, shrinkage of concrete, creep of concrete, relaxation of stress in steel, friction and anchorage; Factors influencing deflection and its importance, short term deflection – tendons of various profile, self weight and imposed loads; 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 and shear; Design of slabs; Design of Anchorage zone using IS and Magnel methods. **Continuous PSC members:** Advantages, primary moment, secondary moment, resultant moment, pressure or thrust line, line of prestress, concordant cable profile, concept of linear transformation, analysis of two span continuous beams. **Circular prestressing:** Analysis & design of prestressed concrete pipes, poles and water tanks. **Composite PSC members:** Types and analysis of composite members, deflection of composite members.

Learning Resources

1. N. Krishna Raju, Prestressed Concrete, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2018
2. N. Rajagopalan, Prestressed Concrete, Alpha Science International Ltd, New Delhi, 2005
3. T.Y. Lin, & Ned. H. Burns, Design of Prestressed Concrete Structures, John Wiley & Sons, New York, 2010.
4. Arthur H.Nilson, Design of Prestressed Concrete, John Wiley & Sons, New York, 2011.
5. P. Dayaratnam, Prestressed Concrete Structures, Oxford and IBH, New Delhi, 2017.
6. Ramaswamy G.S., Modern pre-stressed concrete design, Arnold Heinimen, New Delhi, 2005.
7. Self learning materials – NPTEL - http://www.nptel.ac.in/courses/105106117/

IS Codes

1. IS 1343: 2012 Code of Practice for Pre Stressed Concrete
2. IS 3370 (Part 3): 1967 Code of Practice for Concrete Structures for the Storage of Liquids-Part 3 Pre stressed Concrete
3. IS 3370 (Part 4): 1967 Code of Practice for Concrete Structures for the Storage –Part-4 Design Tables
4. IS 784:2001 Prestressed concrete pipes (including specials) - Specification.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures	Course Outcomes
1.	**Systems of prestressing and its analysis**		
1.1	Basic concepts of prestressing, need for high strength steel and concrete, advantages, applications and partial prestressing	1	CO1
1.2	Pre-tensioning system – Hoyer’s method	1	CO1
1.3	Post-tensioning systems – Freyssinet, Gifford-Udall, Magnel-Blaton, Lee-McCall systems	2	CO1
1.4	Analysis of prestress -resultant stress at a section – concentric tendon, eccentric tendon, bent tendon, parabolic tendon, pressure line or thrust line, concept of load balancing, cracking moment.	2	CO1
2.	**Losses of prestress and Deflection of PSC members**		
2.1	Loss of prestress due to elastic deformation of concrete and shrinkage of concrete	1	CO2
2.2	Loss of prestress due to creep of concrete and relaxation of stress in steel	1	CO2
2.3	Loss of prestress due to friction and anchorage	1	CO2
2.4	Factors influencing deflection and its importance	1	CO2
2.5	Short term deflection – tendons of various profile – self weight and imposed loads; long term deflections	2	CO2
3.	**Flexural and shear strength of PSC members**		
3.1	IS codal provisions - Flexural strength	1	CO3
3.2	Shear resistance – web shear crack, flexure-shear cracks	1	CO3
3.3	Design of sections for flexure	1	CO3
3.4	Design of section for shear	1	CO3
3.5	Design of slabs	1	CO3
3.6	Design of Anchorage zone reinforcement - IS and Magnel methods	2	CO3
4.	**Continuous PSC members**		
4.1	Advantages, primary moment, secondary moment, resultant moment, pressure or thrust line, line of prestress	1	CO4
4.2	Concordant cable profile, concept of linear transformation	1	CO4
4.3	Analysis of two span continuous beams - Procedure	2	CO4
4.4	Analysis of two span continuous beams	2	CO4

5.	**Circular prestressing**		
5.1	Analysis & design of prestressed concrete pipes	2	CO5
5.2	Analysis & design of prestressed concrete pole	2	CO5
5.3	Analysis & design of water tanks	2	CO5
6.	**Composite Construction**		
6.1	Types of composite members	1	CO6
6.2	Analysis of composite members	2	CO6
6.3	Deflection of composite members	2	CO6
	Total	**36**	

Course Designers:

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22CEPD0	BRIDGE ENGINEERING

Category	L	T	P	Credit
PSE	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

Design of reinforced concrete elements

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level%
CO1	Understand the different type of bridges and its alignments and site selection and hydraulics particulars	TPS2	B	70
CO2	Design of culverts and deck slab bridges	TPS3	B	65
CO3	Design of T beam deck slab bridges for IRC loadings	TPS3	B	65
CO4	Design box girders	TPS3	B	65
CO5	Design prestressed concrete bridges	TPS3	B	65
CO6	Design of bridge bearings and piers	TPS3	B	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	25	-	-	-	-	-	-	-	-	-	-	1	10	-	-	-	-	-	20			-	-	-	-	-	-	-	-
CO2	5	-	30	-	-	-	-	-	-	-	-	-	2	-	16	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	5	-	30	-	-	-	-	-	-	-	-	-	2	-	16	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	-	25	-	-	-	2	-	16	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-
CO5	-	-	-	-	-	-	5	-	30	-	-	-	1	-	16	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-
CO6	-	-	-	-	-	-	5	-	30	-	-	-	2	-	16	-	-	-	-	-	-	-	-	-	-		30	-	-	-

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 **Design of beam and slab bridges:** Slab design as Effective width analysis - Design of T beam deck slab bridges for IRC loadings - Pigeauds methods - Design of longitudinal girder - Courbans theory - Design principles of box girder bridges - Design of Box girder bridges **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:** Types of bearings, forces on bearings, basis for selection of bearings - design of steel rocker bearing - design of roller bearing - **substructures for bridges** Types of bridge foundation - design of piers - design principles of abutments and wing walls **-** piles and wells - general features - maintenance and inspection of bridges.

Learning Resources

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
4. IRC: 78, "Standard specifications & Code of practice for Road Bridges".Section VII-Foundation and Substructures.
5. IRC: 6-2000, " Standard specifications & Code of practice for Road Bridges".Section II-Loads and Stresses.
6. IRC: 21-2000, " Standard specifications & Code of practice for Road Bridges".Section III-Cement Concrete (Plain and Reinforced).
7. IRC: 83 Part II-1987, "Standard specifications & Code of practice for Road Bridges".Section : 9 Bearing, Part II – Elastomeric Bearings.
8. IRC: 45-1972, "Recommendations for Estimating the resistance of soil below the maximum scour level in the Design of Well foundations of Bridges.
9. IRC: 24-2000 "Standard specifications & code of practice for steel bridges".
10. IRC: 87-1984, "Guidelines for the Design and Erection of False work for Road Bridges.
11. IS 1343:1980 Code of Practice for Pre Stressed Concrete
12. IRS: 1 1977, Bridge rules.
13. IRS: 2, "Code of practice for plain, reinforced and prestressed concrete for general bridge construction.
14. MOST standard plans for 3.0m to 10m span reinforced cement concrete solid slab superstructure with and without foot paths for highways, (1991).
15. MOST standard plans for highways bridges RCC.T-Beams and slab superstructure – span from 10m to 24m width.

16. 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.
17. MOST standard drawings for road bridges- RCC solid slab superstructure (15° and 30° SKEW) span 4m to 10m (with and without foot paths), 1992.
18. MOST standard drawing for road bridges-RCC solid slab superstructure (22.5°SKEW) span 4m to 10m (with and without foot paths), 1996.
19. IS 2911, 1980 code of practice for pile foundation.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.0	**Introduction**		
1.1	Classification of bridges, investigations and planning, linear water way, economic span length	1	CO1
1.2	IRC specifications for road bridges - standard live loads, other forces acting on bridges	1	CO1
1.3	Indian Railway codal provisions for broad gauge single line and double line, general design considerations	1	CO1
2.0	**Design of culverts and deck slab bridges**		
2.1	General aspects	1	CO2
2.2	Design of slab bridges	2	CO2
2.3	Design of pipe culvert	2	CO2
3.0	**Design of beam and slab bridges**		
3.1	Slab design as Effective width analysis	1	CO3
3.2	Design of deck slab bridges for IRC loadings	2	CO3
3.3	Design of T beam deck slab bridges for IRC loadings	2	CO3
3.4	Pigeauds methods	1	CO3
3.5	Design of longitudinal girder	1	CO3
3.6	Courbans theory	1	CO3
3.7	Design principles of box girder bridges	1	CO3
3.8	Design of Box girder bridges	2	CO3
4.0	**Prestressed concrete bridges**		
4.1	Concept, analysis and systems	1	CO4
4.2	Analysis and design principles of I girders	2	CO4
4.3	Analysis and design principles of box type girder	1	CO4
4.4	Launching and erection details with case studies	1	CO4
4.5	Segmental construction principles	1	CO4
5.0	**Bearings**		
5.1	General features - Types of bearings, Forces on bearings	1	CO5
5.2	Design of steel rocker bearing	2	CO5
5.3	Design of roller bearing	2	CO5
6.0	**Substructures for bridges**		
6.1	Types of bridge foundation	1	CO6
6.2	Design of piers	2	CO6
6.3	Design principles of abutments and wing walls	1	CO6
6.4	Design principles of piles and wells	1	CO6
6.5	Maintenance and inspection of bridges	1	CO6
	TOTAL	**36**	

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22CEPE0	FRACTURE MECHANICS

Category	L	T	P	Credit
PSE	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

Mechanics of Materials

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level%
CO1	Understand the various theories of failures of structural materials with pre existing cracks	TPS2	B	65
CO2	Apply the principles of Linear Elastic Fracture Mechanics	TPS3	B	65
CO3	Understand Elastic Plastic Fracture Mechanics	TPS2	B	65
CO4	Understand the Fatigue Crack Growth principle	TPS2	B	65
CO5	Understand the principles of Crack Arrest mechanism	TPS2	B	65
CO6	Apply the Numerical methods to predict the crack growth	TPS3	B	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	25	-	-	-	-	-	-	-	-	-	-	2	12	-	-	-	-	-	30			-	-	-	-	-	-	-	-
CO2	5	-	35	-	-	-	-	-	-	-	-	-	2	-	20	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	5	25	-	-	-	-	-	-	-	-	-	-	2	12	-	-	-	-	-	30	-		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	25	-	-	-	-	2	12	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-	-
CO5	-	-	-	-	-	-	5	25	-	-	-	-	2	12	-	-	-	-	-	-	-	-	-	-	-	30		-	-	-
CO6	-	-	-	-	-	-	5	-	35	-	-	-	2	-	20	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-

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

Learning Resources

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

Module No.	Topic	No. of Hours	Course Outcome
1.0	**Introduction**		
1.1	Review of Engineering Failure Analysis	1	CO1
1.2	Inglish Stress concentration factors	1	CO1
1.3	Brittle fracture-Ductile fracture	2	CO1
1.4	Modes of fracture failure	1	CO1
1.5	The Griffith energy Balance Approach	1	CO1
1.6	Crack tip Plasticity, Fracture toughness	1	CO1
2.0	**Linear Elastic Fracture Mechanics**		
2.1	Elastic crack tip stress field	1	CO2
2.2	Stress and displacement fields in isotropic elastic materials	1	CO2
2.3	Westergaard's approach (opening mode)	1	CO2
2.4	Plane Strain Fracture toughness (KIC) testing	1	CO2
2.5	Feddersen approach, Determination of R curve.	1	CO2
2.6	Energy released rate for DCB specimen	1	CO2
2.7	Anelastic deformation at crack tip	1	CO2
2.8	K_{1c} Test techniques, Various test specimens	1	CO2
2.9	Critical energy release rate	1	CO2
3.0	**Elastic Plastic Fracture Mechanics**		
3.1	limitation of K approach	1	CO3
3.2	Approximate shape and size of the plastic zone	1	CO3
3.3	Effective crack length	1	CO3
3.4	Effect of plate thickness	1	CO3
3.5	Elastic plastic fracture concept	1	CO3
3.6	Crack tip opening displacement	1	CO3
3.7	Dugdale approach	1	CO3
3.8	Path independence ,Critical J integral	1	CO3
3.9	Evaluation of CTOD	1	CO3
3.10	Relationship between CTOD, K_1 and G_1 for small scale yielding	1	CO3
4.0	**Mixed-mode fracture analysis**		
4.1	First order crack kinking theory	2	CO4
4.2	second order crack kinking theory	1	CO4
4.3	interaction diagram	1	CO4
5.0	**Crack Arrest & Numerical methods**		
5.1	Principles of crack arrest, crack arrest in practice	1	CO5
5.2	K-R Curves	1	CO5
5.3	Crack resistance curve	1	CO5
5.4	Numerical Methods and Approaches in Fracture Mechanics	1	CO6
5.5	Direct methods to determine fracture parameters	1	CO6
5.6	Indirect methods to determine fracture parameters	1	CO6
	Total	**36**	

Course Designers:

1. Dr.R.Ponnudurai rpdciv@tce.edu

22CEPF0	INSTRUMENTATION IN CIVIL ENGINEERING

Category	L	T	P	Credit
PSE	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

Fundamentals of physics

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level%
CO1	Understand the basic circuits for measuring instruments	TPS2	B	70
CO2	Apply the instrument techniques which is suited for structural related problem in civil engineering	TPS3	B	65
CO3	Apply seismic instruments for measuring the motion of vibration in structures	TPS3	B	65
CO4	Apply for the environmental related problems by using the various measuring instruments	TPS3	B	65
CO5	Understand the principle for usage of flow meters in flow measurements	TPS2	B	70
CO6	Apply various NDT technique to solve practical problems and its principle of operation	TPS3	B	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	25	-	-	-	-	-	-	-	-	-	-	1	11	-	-	-	-	-	20			-	-	-	-	-	-	-	-
CO2	5	-	30	-	-	-	-	-	-	-	-	-	2	-	17	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	5	-	30	-	-	-	-	-	-	-	-	-	2	-	17	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	-	30	-	-	-	2	-	17	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-
CO5	-	-	-	-	-	-	5	25	-	-	-	-	1	11	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-
CO6	-	-	-	-	-	-	5	-	30	-	-	-	2	-	17	-	-	-	-	-	-	-	-	-	-		40	-	-	-

Syllabus

Basic forces for indicating instruments-Introduction - Permanent moving coil instrument- Shunts and Multipliers - Moving iron instruments - 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. **NDT Methods -** Rebound hammer method ,Ultra sonic pulse velocity technique- X-ray method, Gamma ray method- Photo elastic bench -plane and circular polariscope - Open circuit potential measurements -Corrosion measurements

Learning Resources

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

Module No.	Topic	No. of Hours	Course Outcome
1	**Basic forces for indicating instruments**		
1.1	Introduction - Permanent moving coil instrument	1	CO1
1.2	Shunts and Multipliers , Moving iron instruments	1	CO1
1.3	Construction and operating principles of attraction and repulsion types	1	CO1

1.4	Wheat stone bridge Kelvin's double bridge	1	CO1
1.5	Maxwell's bridge, Hay's bridge, Wein bridge	1	CO1
2	**Structural Instrumentation**		
2.1	Classification of transducers - Capacitive, inductive, photo electric transducer	1	CO2
2.2	LVDT ,velocity transducer	1	CO2
2.3	Load cell, Hydraulic load cell, Pneumatic load cell, Torque meter and Load cells using strain gauges	1	CO2
2.4	Elastic force transducers, Elcometer	1	CO2
2.5	Cathode ray tube, Principle of operation	1	CO2
2.6	X-Y recorder, Strip chart recorder, Galvanometric type strip chart recorder	1	CO2
3	**Motion Measurements**		
3.1	Relative motion measuring devices, Vibration measurements	1	CO3
3.2	Principle of seismic instruments	1	CO3
3.3	Displacement measurements, Acceleration measurement	1	CO3
3.4	Velocity measurement Time and frequency measurement	1	CO3
3.5	Angular motion measurement, Eddy current drag cup tachometer	1	CO3
3.6	Optical methods Pneumatic gauges, Surface roughness measurements	1	CO3
3.7	Stylus method, Photo electric type tachometer	1	CO3
4	**Environmental pollution**		
4.1	Orsat apparatus, Gas chromatograph	1	CO4
4.2	Measurement of automobile emission, stack emission	1	CO4
4.3	Viscosity measurement, Capillary tube viscometer	1	CO4
4.4	Liquid level measurement, Rotameter type viscometer	1	CO4
4.5	Efflux viscometer, Slight glass method	1	CO4
4.6	Capacitance type liquid gauge	1	CO4
4.7	Ultrasonic liquid level gauge	1	CO4
5	**Flow measurements**		
5.1	Primary methods	1	CO5
5.2	Ultrasonic flow meter, Electromagnetic flow meter	1	CO5
5.3	Turbine flow meter	1	CO5
5.4	Lobed impeller meter, Rotary vane flow meter	1	CO5
6	**NDT Methods**		
6.0	Rebound hammer method, Ultra sonic pulse velocity technique	1	CO6
6.1	X-ray method, Gamma ray method	1	CO6
6.2	Plane polariscope	1	CO6
6.3	Circular polariscope	1	CO6
6.4	Corrosion measurements - linear polarization resistance	1	CO6
6.5	Open circuit potential measurements	1	CO6
6.6	Electrical impedance spectroscopy	1	CO6
	Total Hours	**36**	

Course Designers:

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2. R.Indrajith Krishnan jith@tce.edu

22CEPG0	DISASTER MITIGATION AND MANAGEMENT

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

This course deals with the earthquake disaster and their effects against built structures, and Hazard Assessment procedure in India. This course also deals with the methods of mitigating various hazards such that their risk and impact on communities is reduced.

Prerequisite

Nil

Course Outcomes

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

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Understand the various types of disaster and disaster management cycle	TPS2	B	70
CO2	Apply the basics of vibration for Earthquake hazard	TPS3	B	70
CO3	Identify the potential deficiencies exist in RC building and masonry buildings	TPS2	B	70
CO4	Apply the principle of liquefaction to identify the potential for liquefied soil and introduce DSHA	TPS3	B	70
CO5	Understand the vulnerability reduction technique adopted by NDRF, State and local bodies	TPS2	B	70
CO6	Understand the capacity enhancement in the form of life saving skills and community and contingency plan	TPS2	B	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	25	-	-	-	-	-	-	-	-	-	-	2	12		-	-	-	-	30			-	-	-	-	-	-	-	-
CO2	5	-	35	-	-	-	-	-	-	-	-	-	2	-	20	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	5	25	-	-	-	-	-	-	-	-	-	-	2	12	-	-	-	-	-	30	-		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	-	35	-	-	-	2	-	20	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-
CO5	-	-	-	-	-	-	5	25	-	-	-	-	2	12	-	-	-	-	-	-	-	-	-	-	-	30		-	-	-
CO6	-	-	-	-	-	-	5	25	-	-	-	-	2	12	-	-	-	-	-	-	-	-	-	-	-	30		-	-	-

Syllabus

Hazard and disaster: Over view of Disaster Management **Earthquake Disaster:** Causes of vibration Free vibration of SDOF system, Free damped vibration of SDOF system, Vibrating measuring instruments **Earthquake resistant measures:** Causes of Earthquakes, Earthquake Size Seismic waves, Earthquake resistant measures in RC buildings, Earthquake resistant measures in Masonry buildings **Liquefaction potential:** Introduction, Causes, types, preparation of hazard zonation map, Liquefaction, Evaluation of Liquefaction potential, Slope failures, Protection measures **Role and responsibility of NDRF:** Collapsed Structure Rescue **-** Skill variety of NDRF Battalions-MFR- FRRM, CBRN disasters, START system, TRIAGE, FBAO (Foreign body airway Obstruction **Life saving skills:** Search and rescue and evacuation methods, Fire safety technique classification Extinguishers, Life saving skills - Body mechanics - CPR - Burn and its classification, Role of Local and state bodies, RVS Method Screening, Community planning Community Contingency plan

Reference Books:

1. David A. McEntire (2014) Disaster Response and Recovery: Strategies and Tactics for Resilience,Wiley Publishers
2. R. B. Singh (2006) Natural Hazards and Disaster Management: Vulnerability and Mitigation , Rawat Publications
3. Pradyumna P. Karan (2010)The Indian Ocean Tsunami: The Global Response to a Natural Disaster,University Press of Kentucky
4. Matthew R. Stein (2011)When Disaster Strikes: A Comprehensive Guide for Emergency Prepping and Crisis Survival. Chelsea Green Publishing
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” RawatPublications,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 Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**Hazard and disaster**		
1.1	Over view of Disaster Management	1	CO1
2	**Earthquake Disaster**		
2.1	Causes of vibration	1	CO2
2.2	Free vibration of SDOF system	2	CO2
2.3	Free damped vibration of SDOF system	2	CO2
2.4	Vibrating measuring instruments	2	CO2
3	**Earthquake resistant measures**		
3.1	Causes of Earthquakes, Earthquake Size Seismic waves	1	CO3
3.2	Earthquake resistant measures in RC buildings	2	CO3
3.3	Earthquake resistant measures in Masonry buildings	2	CO3
4	**Liquefaction potential**		
4.1	Introduction, Causes, types, preparation of hazard zonation map	2	CO4

4.2	Liquefaction	2	CO4
4.3	Evaluation of Liquefaction potential	2	CO4
4.4	Slope failures	2	CO4
4.5	Protection measures	1	CO4
5	**Role and responsibility of NDRF**		
5.1	Collapsed Structure Rescue **-** Skill variety of NDRF Battalions-MFR- FRRM, CBRN disasters	2	CO5
5.2	START system, TRIAGE, FBAO (Foreign body airway Obstruction	2	CO5
6	**Life saving skills**		
6.1	Search and rescue and evacuation methods	2	CO6
6.2	Fire safety technique classification Extinguishers	2	CO6
6.3	Life saving skills - Body mechanics - CPR - Burn and its classification	2	CO6
6.4	Role of Local and state bodies, RVS Method Screening	2	CO6
6.5	Community planning Community Contingency plan	2	CO6
	TOTAL	**36**	

Course Designer(s):

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2. Ms. M. Aruna maciv@tce.edu

22CEPH0	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.

Prerequisite

Nil

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Explain the factors affecting the durability of concrete structures	TPS2	B	80
CO2	Identify the causes and effects of distress in concrete structures	TPS2	B	80
CO3	Diagnose the condition of concrete structures using visual, Non-Destructive and Destructive approaches with case studies.	TPS3	B	80
CO4	Enumerate the concept of quality assurance in structures, basic mechanisms by which quality assurance schemes are developed and operated.	TPS3	B	80
CO5	Suggest suitable materials of repair related to the distress with case studies	TPS3	B	80
CO6	Suggest suitable techniques of repair/rehabilitation to distress structures with case studies	TPS3	B	80

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	20	-	-	-	-	-	-	-	-	-	-	5	5	-	-	-	-	-	-	20		-	-	-	-	-	5	20	-
CO2	5	-	20	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	40		-	-	-	-	-	5	-	20
CO3	5	5	40	-	-	-	-	-	-	-	-	-	5	-	20	-	-	-	-	-	40		-	-	-	-	-	5	5	40
CO4	-	-	-	-	-	-	5	10	20	-	-	-	5	5		-	-	-	-	-	-	-	-	-	-		20	-	-	-
CO5	-	-	-	-	-	-	5	-	20	-	-	-	5	5	-	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO6	-	-	-	-	-	-	5	5	30	-	-	-	5	-	20	-	-	-	-	-	-	-	-	-	-		40	-	-	-

Syllabus

Durability of Concrete Structures - 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 and effects** - effects due to climate, temperature, chemicals, wear and erosion, design and construction errors, Effects of distress in concrete structures, Cracks, delamination, Pop outs, Scaling. Effects due to disasters. **Quality of Concrete structures-** Condition Assessment- Inspection, structural appraisal, economic appraisal- Diagnosis of distress – Procedure, Methods of assessing the quality of concrete-NDT and DT. Quality assurance – need- components- conceptual bases of quality assurance schemes, Basic methods of development and operation of QAS. **Materials for Repair –** Special cements for accelerated strength gain, expansive cement, Dry pack, preplaced aggregate concrete, epoxy bonded concrete, shotcrete, Gunite, silica fume concrete, polymer concrete system, self-healing concrete, foam concrete, Fibre reinforced Polymers. **Techniques of Repair/Rehabilitation –** Rust eliminators and polymer coating for rebars during repair, Crack treatment, Plate bonding, RCC jacketing, Fibre wrap technique, Foundation rehabilitation methods, Case studies on distress concrete structures and type of treatment done.

Learning Resources

1. Dension Campbell, Allen and, Harold Roper, “Concrete Structures, Materials, Maintenance and Repair”, Longman Scientific and Technical Publications UK, 1991
2. R.N.Raikar, “Building Failures: Diagnosis and avoidance”,Structwel Designers & Consultants, R & D Centre (1994)
3. Shetty. M.S., “Concrete Technology – Theory and Practice”, S.Chand Company, New Delhi, 2010
4. NPTEL course on Structural Health Monitoring: https://nptel.ac.in/courses/114106046/
5. NPTEL course on Theory and Practice of Non Destructive Testing https://archive.nptel.ac.in/courses/113/106/113106070/
6. “Quality assurance manual for Building works 2022” by CPWD.
7. “Handbook on Repair and Rehabilitation of RCC buildings” by CPWD.
8. Robert T. Ratay “Forensic Structural Engineering Handbook, Second Edition” 2010, the McGraw-Hill Companies, Inc ISBN: 9780071498845.
9. Lecture notes on “Three days workshop on "Condition Assessment and Rehabilitation of Structures (CARS 2017)" at National Institute of Technology, WARANGAL(NITWarangal), 17-03-2017 to 19-03-2017

Course Contents and Lecture Schedule

Module No.	Topics	No. of Hours	Course Outcome
1.	**Durability of Concrete Structures**		
1.1	Durability of concrete in sea water- action of sewage – influencing factors	1	CO1
1.2	Thermal properties of concrete – fire resistance - factors influencing	1	
1.3	Resistance to freezing and thawing- influencing factors	1	
1.4	Resistance to abrasion, erosion and cavitation – influencing factors	1	
2.	**Distress in concrete structures- causes and effects**		
2.1	Effects due to climate, temperature, chemicals – causes and effects	1	CO2
2.2	Design and construction errors –causes and effects	2	
2.3	Effects of distress in concrete structures- Cracks, delamination, Pop outs, Scaling.	2	
2.4	Effects due to disasters- Earthquake, flood, Tsunami, Cyclones.	2	

3.0	**Quality of Concrete Structures**		
3.1	**Condition Assessment**		
3.1.1	Inspection, types of maintenance, structural appraisal, economic appraisal, Diagnosis of distress – Procedure	2	CO3
3.1.2	Methods of assessing the quality of concrete – Rapid visual Inspection survey, NDT and DT tests	2	
3.2	**Quality assurance**		
3.2.1	Need and Objectives- people benefited by QAS	1	CO4
3.2.2	Organization for QA, 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 cements for accelerated strength gain, expansive cement – properties, methods of manufacture and applications	2	CO5
4.2	Dry pack and Epoxy bonded Dry pack, Preplaced aggregate concrete, Epoxy bonded concrete.	2	
4.3	Shotcrete, Gunite, Silica fume concrete, Polymer concrete system,	2	
4.4	Self healing concrete, foam concrete, Fibre reinforced Polymers - properties, methods of manufacture and applications	2	
5.	**Techniques of Repair/Rehabilitation**		
5.1	Rust eliminators and polymer coating for rebars during repair, protective seal coat	2	CO6
5.2	Crack treatment- epoxy injection, mortar repair for cracks	1	
5.3	Plate bonding, RCC jacketing, propping and supporting.	2	
5.4	Fibre wrap technique, Foundation rehabilitation methods.	2	
5.5	Case studies on distress concrete structures and type of treatment done. Forensic investigations – case studies	1	
	Total Periods	**36**	

Course Designers:

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22CEPJ0	ADVANCED REINFORCED CONCRETE DESIGN

Category	L	T	P	Credit
PSE	3	0	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.

Prerequisite

22CE620 Design of Reinforced Concrete Elements

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Design special elements such as deep beams, corbels and curved beams and detail the reinforcement	TPS3	B	70
CO2	Design special elements such as shear wall, bunkers and silos and detail the reinforcement	TPS3	B	70
CO3	Design special elements such as Virendeel girders and poles and detail the reinforcement	TPS3	B	70
CO4	Design reinforced concrete pipes under various types of loading and detail the reinforcement	TPS3	B	70
CO5	Design formworks for column, beam and floor slab and detail the reinforcement	TPS3	B	70
CO6	Analyse and design the concrete trusses and detail the reinforcement	TPS3	B	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
CO1	4	4	25	-	-	-	-	-	-	-	-	-	2	2	15	-	-	-	-	-	30		-	-	-	-	-	-	-	-
CO2	4	2	30	-	-	-	-	-	-	-	-	-	2	-	15	-	-	-	-	-	35		-	-	-	-	-	-	-	-
CO3	4	2	25	-	-	-	-	-	-	-	-	-	2	2	10	-	-	-	-	-	35		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	4	4	30	-	-	-	2	2	15	-	-	-	-	-	-	-	-	-	-		35	-	-	-
CO5	-	-	-	-	-	-	4	2	25	-	-	-	2	2	15	-	-	-	-	-	-	-	-	-	-		35	-	-	-
CO6	-	-	-	-	-	-	4	2	25	-	-	-	2	-	10	-	-	-	-	-	-	-	-	-	-		30	-	-	-

Syllabus

Design of Special Elements: Deep beams, corbels, curved beams, shear wall, bunkers – square, rectangular and circular bunkers; silos, virendeel girders and poles; Reinforcement detailing. **Design of reinforced concrete pipes**: Under 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; Reinforcement detailing. **Design of form works**: Shuttering for columns, beams and floor slabs; Detailing of form works. **Design of concrete trusses**: Constructional features, analysis of trusses, design of FINK truss (Precast); Reinforcement detailing.

Learning Resources

1. N. Krishna Raju Advanced Reinforced Concrete Design IS 456-2000, CBS Publishers and Distributors, New Delhi, Third Edition, 2020.
2. P.C. Varghese, Advanced Reinforced Concrete Design, Prentice Hall of India, Pvt. Ltd., New Delhi, 2011.
3. M.L. Gambhir, Design of Reinforced Concrete structures, Prentice Hall of India Private limited, New Delhi, 2012.
4. N. Subramanian, Design of Reinforced Concrete Structures, Oxford University Press, New Delhi, 2014.
5. B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, RCC Designs (Reinforced Concrete Structures), Laxmi Publications Pvt. Ltd., New Delhi, 2015.
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(1-2):1987 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures.
3. IS 875(3):2015 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures
4. IS 875(4-5):1987 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures
5. IS 485: 2003 Precast concrete pipes (with and without reinforcement) – Specification
6. IS 783: 1985 Code of practice for laying of concrete pipes
7. IS 3201: 1988 Criteria for design and construction of precast concrete trusses and purlins
8. 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
9. IS 785: 1998 Reinforced concrete poles for overhead tower and telecommunication lines – Specification.
10. SP 16:1980 Design Aids for Reinforced Concrete to IS 456:1978.
11. SP 34:1987 Handbook of concrete reinforcement and detailing

Course Contents and Lecture Schedule

Module No.	Topics	No of Lectures	Course Outcomes
1.0	**Design of Special Elements**		
1.1	Deep beams and its reinforcement detailing	2	CO1
1.2	Corbels and its reinforcement detailing	2	CO1
1.3	Curved beams and its reinforcement detailing	2	CO1
1.4	Shear wall and its reinforcement detailing	2	CO2
1.5	Bunkers – square and its reinforcement detailing	2	CO2
1.6	Bunkers –rectangular and circular and its reinforcement detailing	2	CO2
1.7	Silos and its reinforcement detailing	2	CO2
1.8	Virendeel girders and its reinforcement detailing	2	CO3
1.9	Poles and its reinforcement detailing	2	CO3
2.0	**Design of reinforced concrete pipes**		
2.1	Under Hydrostatic pressure, self weight and weight of water - reinforcement detailing	2	CO4
2.2	Under Earth fill over haunches, UDL on top and uniform pressure from sides - reinforcement detailing	2	CO4
2.3	Under triangularly distributed load, point load on crown, overburden and external loads - reinforcement detailing	2	CO4
3.0	**Design of form works**		
3.1	Shuttering for columns and its detailing	2	CO5
3.2	Shuttering for beams and its detailing	2	CO5
3.3	Shuttering for floor slabs and its detailing	2	CO5
4.0	**Design of concrete trusses**		
4.1	Constructional features and analysis of trusses	2	CO6
4.2	Design principles of concrete truss	2	CO6
4.3	Design of FINK truss (Precast) and its reinforcement detailing	2	CO6
	TOTAL	**36**	

Course Designers:

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22CEPK0	COMPUTATIONALMETHODSIN STRUCTURAL ANALYSIS

Category	L	T	P	Credit
PSE	3	-	-	3

Preamble

It is common practice to use approximate solutions of differential equations as the basis for structural analysis. This is usually done using numerical approximation techniques. The most commonly used numerical approximation in structural analysis is the Finite Element Method. This course endeavours to fulfil two principal objectives. First, it acquaints matrix methods of structural analysis and their underlying concepts and principles. After a thorough presentation of mathematical tools and theory required for linear elastic analysis of structural systems, the course focuses flexibility and stiffness methods of analysis for computer usage. The direct stiffness method is the backbone of most computer programs is also discussed. Besides, the physical behavior of structures is analysed throughout with the help of axial thrust, shear force, bending moment and deflected shape diagrams.

Prerequisite

22CE320-Mechnics of Solids, 22CE420-Structural Analysis

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Compute the internal moment and by establishing BMD for beams and frames by flexibility method	TPS3	B	65
CO2	Solve for member forces of trusses and grids by flexibility method	TPS3	B	65
CO3	Calculate the internal moment and the resultant BMD of beams, frames using stiffness method	TPS3	B	65
CO4	Resolve the member forces of trusses and grids by stiffness method	TPS3	B	65
CO5	Solve for the internal forces and construct the BMD for Beams and plane frames by direct stiffness method	TPS3	B	65
CO6	Prepare the member forces report for the trusses and grids by direct stiffness method	TPS3	B	65

*** Weightage depends on Bloom's Level, number of contact hours,

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Assessment	CAT1		CAT2		Terminal exam		Assignment 1	Assignment 2
TPS / COs	2	3	2	3	2	3	3	3
CO1	10	25	-	-	4	10	30	-
CO2	10	20	-	-	2	10	35	-
CO3	10	25	-	-	4	15	35	-
CO4	-	-	10	25	4	15	-	30
CO5	-	-	10	20	4	15	-	35
CO6	-	-	10	25	2	15	-	35

Syllabus

Review of Fundamental Concepts: Introduction – Forces and Displacement relationships – Principle of superposition – Methods of Structural Analysis – Betti's Law – Stiffness and Flexibility matrices of the Elements – a review. **Transformation of Information:** Indeterminate Structures – Transformation of system force to element forces – Element flexibility to System flexibility – system displacement to element displacement – Transformation of forces and displacement in general – Normal and orthogonal transformation. **Flexibility Method:** Choice of redundant – ill and well-conditioned equations – Automatic choice of redundant – Rank technique – Transformation of one set of redundant to another set – Thermal expansion – Lack of fit – Application to pin jointed plane truss – continuous beams - frames and grids. **Stiffness Method:** Development of stiffness method – analogy between flexibility and stiffness – Analysis due to thermal expansion, lack of fit – Application to pin-jointed plane and space trusses – Continuous beams – frames and grids – problem solving. **Matrix Displacement Methods - Special Topics:** Static condensation Technique – Substructure Technique - Transfer Matrix method – Symmetry & Anti symmetry of structures – Reanalysis Technique. **Direct Stiffness Method:** Discrete system – Direct stiffness approach – Application to beams, plane frames and two dimensional pin-jointed trusses –Grids.

Learning Resources

1. Rajesekharan & Sankarasubramanian G., “Computational Structural Mechanics”, Prentice Hall of India, 2001.
2. Damodar Maity, “Computer Analysis of Framed Structures”, I K International, 2007
3. Mukhopadhyay M., “Matrix Finite Element Computer and Structural Analysis”, Oxford & IBH, 1984.
4. Reddy C.S., “Basic Structural Analysis”, Tata McGraw Hill Publishing Co.1996.
5. Seeli F.B.& Smith J.P., “Advanced Mechanics of Materials”, John Wiley &Sons, 1993.
6. Smith J.C. “Structural Analysis”, Macmillian Pub.Co.1985.
7. Pezemieniecki, J.S, “Theory of Matrix Structural Analysis”, McGraw Hill Co.,1984.
8. Meek J.L., “Matrix Structural Analysis”, McGraw Hill, 1971.
9. Moshe F Rubinstein– “Matrix Computer Analysis of Structures”– Prentice Hall, 1969.
10. Wang C.K & Solomon C.G.,” Introductory Structural Analysis”, McGraw Hill,1968.
11. Weaver & Gere, “Matrix Analysis of Structures”,3rd edition, East West Press, 1988.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	Course Outcome
1. Review of Fundamental Concepts			
1.1	Introduction – Forces and Displacement Measurements	1	CO1 & CO2
1.2	Principle of superposition		
1.3	Methods of Structural Analysis – Betti's Law	1	
1.4	Stiffness and Flexibility matrices of the Elements – a review		
2. Transformation of Information			
2.1	Indeterminate Structures - Transformation of system force to element forces	1	CO1 & CO2
2.2	Element flexibility to System flexibility		
2.3	System displacement to element displacement	1	
2.4	Transformation of forces and displacement in general		
2.5	Normal and orthogonal transformation		
3. Flexibility Method			
3.1	Choice of redundants	1	CO3& CO4
3.2	Ill and well-conditioned equations, Automatic choice of redundants		
3.3	Rank technique, Transformation of one set of redundants to another set	1	
3.4	Thermal expansion – Lack of fit		
3.5	Application to pin jointed plane truss	2	
3.6	Analysis of Continuous beams	2	
3.7	Analysis of Frames	2	
3.8	Analysis of grids	2	
4. **Stiffness Method**			
4.1	Development of stiffness method	1	CO3& CO4
4.2	Analogy between flexibility and stiffness		
4.3	Analysis due to thermal expansion, lack of fit	1	
4.4	Application to pin-jointed plane trusses	2	
4.5	Analysis of Continuous beams	2	
4.6	Analysis of Plane Frames	2	
4.7	Analysis of Grids	2	

5. Matrix Displacement Methods - Special Topics:			
5.1	Static condensation Technique	1	CO4
5.2	Substructure Technique	1	
5.3	Transfer Matrix method		
5.4	Symmetry & Anti symmetry of structures	1	
5.5	Reanalysis Technique		
6. Direct Stiffness Method			
6.1	Discrete system	1	CO5& CO6
6.2	Direct stiffness approach		
6.3	Application to two dimensional pin-jointed trusses	2	
6.4	Application to continuous beams	2	
6.5	Application to Plane frames	2	
6.6	Application to Grids	2	
	Total periods	**36**	

Course Designers:

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Category	L	T	P	Credit
PSE	3	0	0	3

22CEPL0	STRUCTURAL MASONRY

Preamble

This course covers the material and engineering aspects of brick units and mortars etc. This mainly focuses on the design of unreinforced and reinforced brick masonry structures as per the Indian Standard IS:1905. This also deals with two types of load such as uniformly distributed loads and concentrated loads. At last, the course discussed the general guidelines for Earthquake resistant brick masonry buildings.

Prerequisite

Nil

Course Outcomes

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

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency (Grade)	Expected Attainment level (%)
CO1	Comprehend the material and engineering properties of masonry units, mortar, grout and reinforcement and the relevant codes and standards	TPS2	B+	65
CO2	Design the brick masonry solid and cavity walls with or without pilasters under uniformly distributed or concentrated loads or concentrated load with an eccentric also the design columns/piers	TPS3	B+	65
CO3	Solve a brick masonry solid wall with an opening considering or not considering the pilaster under uniformly distributed or concentrated loads.	TPS3	B+	65
CO4	Study the strength of brick masonry shear walls and compound walls with or without pilasters under lateral loads	TPS3	B+	65
CO5	Design a reinforced brick masonry wall, lintels and slabs	TPS3	B+	60
CO6	Expound on the behaviour of masonry against seismic effect and also comprehend the best practices and Indian standard provisions on the construction aspects of brick masonry	TPS2	B+	60

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Assessments	Assessment - I						Assessment - II						Terminal Exam		
	CAT1			Assignment-I*			CAT-II			Assignment-II*					
TPS / COs	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	5	5	10	-	-	-	-	-	-	-	-	-	-	5	
CO2	5	5	30	-	-	50	-	-	-	-	-	-	2		20
CO3	5	5	30	-	-	50	-	-	-	-	-	-	2		20
CO4	-	-	-	-	-	-	5	5	30	-	-	30	2		20
CO5	-	-	-	-	-	-	5	5	30	-	-	40	2		20
CO6	-	-	-	-	-	-	5	5	10	-	-	30	2	5	
Total	15	15	70			100	15	15	70			100	10	10	80

*Assignment I, II –Quiz/ Case analysis/ Problem-solving/ Presentation/ Writing tasks

Syllabus

Introduction about masonry – Overview of brick masonry in historic and modern buildings – Types of bricks - Methods of design – Codes and standards – Material properties and testing of components – Masonry units clay and concrete blocks, mortar, grout and reinforcement – Bond pattern, shrinkage and differential movements. **Strength of Brick Masonry under compression** – Principles - Design of solid and cavity walls with or without stiffener - uniformly distributed loads – concentric and eccentric concentrated loads as per IS: 1905 – column, Pier and foundation. Design of masonry with or without opening - **Strength of Brick Masonry under Lateral loads** – Masonry under lateral loads – design of shear wall – design of compound walls with or without pilasters – retaining wall – **Design of reinforced brick masonry** – limit states -Basic design variables – partial safety factors – Design of reinforced brick masonry flexural members – reinforced brick lintels – reinforced brickwork slabs – **Earthquake resistance design of brick masonry** – Seismic behaviour of masonry building – Behaviour of brick masonry wall – Improvement of the behaviour of masonry walls – Masonry building with simple configuration - box action of masonry buildings – Role of the horizontal band – design of lintel bands – Response of masonry with vertical reinforcement – protection of opening in walls – Design Consideration of confined brick masonry - Failure of masonry building – the strength of masonry – General construction aspects

Reference Books

1. A.W. Hendry, B.P. Sinha and Davis, S. R, “Design of Masonry Structures”, E & FN Spon, UK, 2017.
2. R.S. Schneider and W.L. Dickey, “Reinforced Masonry Design”, Prentice Hall, 3rd edition, 1994. Paulay, T. and Priestley, M. J. N., “Seismic Design of Reinforced Concrete and Masonry Buildings”, John Wiley, 1992.
3. A.W. Hendry, “Structural Masonry”, 2nd Edition, Palgrave McMillan Press, 1998
4. Drysdale, R. G. Hamid, A. H. and Baker, L. R, “Masonry Structures: Behaviour & Design”, Prentice Hall Hendry, 1994.
5. https://www.nicee.org

List of Standards

1. IS 1905-1987n, Code of Practice for Structural Use of Unreinforced Masonry
2. IS 875-1987, (Part-1,2 &3) Code of Practice for Design Load (other than Earthquake).
3. IS 456-2000 Code of Practice for general construction in RCC.
4. IS:17848 -2022 Code of Practice for confined masonry for earthquake resistance

Course Contents and Lecture Schedule

Module No.	Topics	No. of Hours	Course Outcomes
1.0	**Introduction about masonry**	1	CO1
2.0	Overview of brick masonry in historic and modern buildings.	1	CO1
2.1	Types of Bricks and its classifications	1	CO1
2.2	Methods of design. Discussion on Codes and standards	1	CO1
2.3	Material properties and testing of components	1	CO1
2.4	Masonry units clay and concrete blocks, mortar, grout and reinforcement	1	CO1
2.5	Bond pattern, shrinkage and differential movements	1	CO1
3.0	**Strength of Brick Masonry under compression – Solid and Cavity wall**		
3.1	Principles, Design provision of IS: 1905 – column, Pier and foundation	1	CO2
3.2	Design of solid with or without stiffener - uniformly distributed loads as per IS: 1905	1	CO2
3.3	Design of cavity with or without stiffener - uniformly distributed loads as per IS: 1905	1	CO2
3.4	Design of solid with stiffener under Concentrated loads as per IS: 1905	1	CO2
3.5	Design of cavity wall with stiffener subjected to Concentrated load at an eccentricity as per IS: 1905	1	CO2
3.6	Design of column / Pier	1	CO2
4.0	**Strength of Brick Masonry wall with opening under compression**		
4.1	Design provision for opening in the masonry solid or cavity wall	1	CO3
4.2	Design of solid walls with opening without stiffener - uniformly distributed loads	1	CO3
4.3	Design of Solid walls with opening but with stiffener - uniformly distributed loads	1	CO3
4.4	Design of solid walls with opening but with stiffener – Concentrated load	1	CO3
4.5	Design of Solid walls with opening but with stiffener – Concentrated with eccentricity	1	CO3
5.0	**Strength of Brick Masonry under Lateral loads**		
5.1	Introduction to Masonry under lateral loads	1	CO4
5.2	Design of shear wall	2	CO4
5.3	Design of compound walls without pilasters	1	CO4
5.4	Design of compound walls with pilasters	1	CO4
5.5	Design masonry retaining wall	2	CO4
6.0	**Design of reinforced brick masonry**		
6.1	Limit states and its discussion	1	CO5
6.2	Basic design variables	1	CO5
6.3	Partial safety factors and loads and load combinations	1	CO5
6.4	Design of reinforced brick masonry flexural members.	1	CO5
6.5	Reinforced brick lintels	1	CO5

6.6	Reinforced brickwork slabs	1	CO5
7.0	**Earthquake resistance design of brick masonry**		
7.1	Seismic behaviour of masonry building. Behaviour of brick masonry wall. Improvement of the behaviour of masonry walls	1	CO6
7.2	Masonry building with simple configuration - box action of masonry buildings	1	CO6
7.3	Role of the horizontal band – design of lintel bands. Response of masonry with vertical reinforcement	1	CO6
7.4	Protection of opening in walls – Design Consideration of confined brick masonry	1	CO6
7.5	Failure of masonry building – the strength of masonry – General construction aspects	1	CO6
	Total	36	

Course Designers:

Dr.S.Arulmary samciv@tce.edu

22CEPM0	MUNICIPAL SOLID WASTE MANAGEMENT

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

Solid waste management has been one of the significant issues to be addressed by the urban local body which is responsible for providing basic service to the people. Due to the rapid urbanisation it is difficult to manage the huge quantity of waste generated from the community. So it is necessary and atmost priority to provide a viable solution to tackle the challenge. 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.

Prerequisite

NIL

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency scale	Expected Proficiency	Expected Attainment Level %
CO1	Explain the various functional elements involved in solid waste management system	TPS2	A	65
CO2	Classify, Quantify and characterise the solid wastes generated from a community.	TPS3	A	65
CO3	Analyze the collection system and collection route.	TPS3	A	65
CO4	Select suitable waste processing technologies and disposal methods	TPS3	A	65
CO5	Analyse the options to recover resources from waste generated	TPS3	A	65
CO6	Propose a safe disposal method for municipal solid waste.	TPS3	A	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

CO	CAT1			CAT2			Terminal			ASSIGNMENT I			ASSIGNMENT II		
TPS Scale	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1	10	20	-	-	-	-	3	10	-		30	-			
CO2	5	15	20	-	-	-	3	5	10			30			
CO3	-	10	20	-	-	-	3	5	10			40			
CO4	-	-	-	5	10	20	3	5	10	-	-	-	-	-	30
CO5	-	-	-	5	10	20	3	5	10	-	-	-	-	-	30
CO6	-	-	-		10	20	-	5	10	-	-	-	-	-	40

Syllabus

Introduction: Sources and types of municipal solid waste, Effects of improper Solid Waste Management, Elements of Solid Waste Management, Legal framework for Solid Waste Management in India, Government initiatives to tackle municipal solid waste, Strategic Planning-Decentralization and Micro planning, Principles of circularity & Integrated solid waste management. **Quantification & Characterization:** Waste generation rates and factors affecting generation, Method of sampling and Composition, Characterization of waste, Handling and segregation of waste at source. **Collection and Transfer:** Methods of collection of waste, Collection vehicles, manpower and collection routes & their optimization, Analysis of collection systems, Need for transfer and transport of MSW, Transfer station- Selection of location, operation and maintenance. **Waste processing:** Objectives of MSW processing, Mechanical Processing, Thermal processing-Gasification and RDF, Biological conversion technologies, Principles of Energy conversion processes. **Resource Recovery:** Resource recovery for sustainable development-Circular economy, Recycling technologies for paper, glass, metal and plastic, Bio chemical conversion – Commercial Anaerobic technologies, Biological processing for material recycling-compost and vermiculture, Resource recovery from solid waste- Case studies on Indian conditions and Best Practices. **Disposal:** Open Dumping of solid waste on land -ill effects, Sanitary Landfills- site selection, Design and Operation- Landfill liner, Management of leachate and landfill gas, landfill closure, Legacy waste management, Landfill bioreactor & Dumpsite rehabilitation.

Learning Resources

1. George Tchobanoglous, Hilary Thiesen and Samuel A Vigil, “Integrated Solid Waste Management: Engineering Principles and Management Issues”, McGraw Hill Publishers, New York, 1993.
2. “Manual on Municipal Solid Waste Management”, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2000.
3. Bhide, A. D. and Sundaresan, B. B. “Solid Waste Management Collection, Processing and Disposal”, ISBN 81-7525-282-0, 2001.
4. Paul T Williams, “Waste Treatment and Disposal”, John Wiley and Sons, England, 2005.
5. Manual on municipal solid waste management,2016.
6. NPTEL course on Integrated Solid Waste Management for smart cities.
7. NPTEL course on Plastic Waste Management.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.Introduction			
1.1	Sources and types of municipal solid waste	1	CO1
1.2	Effects of improper Solid Waste Management	1	CO1
1.3	Elements of Solid Waste Management	2	CO1
1.4	Legal framework for Solid Waste Management in India	1	CO1

1.5	Government initiatives to tackle municipal solid waste	1	CO1
1.6	Strategic Planning-Decentralization and Micro planning	1	CO1
1.7	Principles of circularity & Integrated solid waste management	1	CO1
2.Quantification &Characterization			
2.1	Waste generation rates and factors affecting generation	1	CO2
2.2	Method of sampling and Composition	1	CO2
2.3	Characterization of waste	2	CO2
2.4	Handling and segregation of waste at source	1	CO2
3.Collection and Transfer			
3.1	Methods of collection of waste	1	CO3
3.2	Collection vehicles, manpower and collection routes & their optimization	1	CO3
3.3	Analysis of collection systems	1	CO3
3.4	Need for transfer and transport of MSW	1	CO3
3.5	Transfer station- Selection of location, operation and maintenance	1	CO3
4.Waste processing			
4.1	Objectives of MSW processing	1	CO4
4.2	Mechanical Processing	1	CO4
4.3	Thermal processing-Gasification and RDF	2	CO4
4.4	Biological conversion technologies	1	CO5
4.5	Principles of Energy conversion processes	1	CO5
5.Resource Recovery			
5.1	Resource recovery for sustainable development- Circular economy	1	CO5
5.2	Recycling technologies for paper,glass, metal and plastic	1	CO5
5.3	Bio chemical conversion –Commercial Anaerobic technologies	1	CO5
5.4	Biological processing for material recycling-compost and vermiculture	1	CO5
5.5	Resource recovery from solid waste- Case studies on Indian conditions and Best Practices	2	CO5
6.Disposal			
6.1	Open Dumping of solid waste on land -ill effects	1	CO6
6.2	Sanitary Landfills- site selection	1	CO6
6.3	Design and Operation- Landfill liner	1	CO6
6.4	Management of leachate and landfill gas, landfill closure	1	CO6
6.5	Legacy waste management	1	CO6
6.6	Landfill bioreactor & Dumpsite rehabilitation	1	CO6

Course Designers:

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2. Dr.V.RaviSankarenvironmentengr@tce.edu

22CEPN0	AIR AND NOISE POLLUTION MANAGEMENT

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

This 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 methods for analysing the pollutants. Also, it deals with the principles and design for control of particulate, gaseous air pollutants and its emerging trends to fulfil the legal aspects of air pollution. In addition, this course imparts knowledge about the fundamental theory of sound, noise pollution sources with its effects and control techniques.

Course Outcomes

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

CO's	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected attainment level in %
CO1	Identify the sources and effects of air pollution with pollutants sampling techniques and measurements	TPS2	A	70
CO2	Show the significance of meteorological factors in dispersion of pollutants and forecast the pollutant concentration at some distance downwind.	TPS3	A	70
CO3	Apply suitable preventive and control measures for abatement of particulate pollutant.	TPS3	A	70
CO4	Apply suitable preventive and control measures for abatement of gaseous air.	TPS3	A	70
CO5	Identify suitable locations for citing of industries with appropriate air pollution management strategy.	TPS2	A	70
CO6	Identify the sources of noise and its effect on human beings, animals, plants and materials and produce appropriate noise control measures	TPS3	A	70

*** Weightage depends on Bloom's Level, number of contact hours,

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	20	-	-	-	-	-	-	-	-	-	-	4	6	-	-	-	-	-	-	25		-	-	-	-	-	-	-	-
CO2	5	20	-	-	-	-	-	-	-	-	-	-	4	6	10	-	-	-	-	-	25		-	-	-	-	-	-	-	-
CO3	5	20	25	-	-	-	-	-	-	-	-	-	4	6	10	-	-	-	-	-	50		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	20	25	-	-	-	4	6	10	-	-	-	-	-	-	-	-	-	-	-	50	-	-	-
CO5	-	-	-	-	-	-	5	20	-	-	-	-	4	6	-	-	-	-	-	-	-	-	-	-	-	-	15	-	-	-
CO6	-	-	-	-	-	-	5	20	-	-	-	-	4	6	10	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-

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.

Learning Resources

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. Rao M.N and Rao H.V.N, “Air pollution”, Tata McGraw Publishers, 2006.
5. Mahajan, S. P., “Air Pollution Control”, TERI Press, New Delhi, 2009.
6. Anjaneyalu Y, “Air pollution and control technologies”, Allied Publishers (P) Ltd. India, 2020.
7. NPTEL courses

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.0	**Introduction to Air pollution**		
1.1	History of air pollution- Sources of air pollution	1	CO1
1.2	Types of pollutants	1	CO1
2.0	**Effects of air pollutants**		CO1
2.1	Effects of air pollutants on human beings	2	CO1
2.2	Effects of air pollutants on animals and plants	1	CO1
2.3	Effects of air pollutants on materials	1	CO1
2.4	Effects of air pollutants on global environment – Global warming	1	CO1
2.5	Ozone layer depletion, acid rain	1	CO1
3.0	**Sampling and analysis**		CO1
3.1	Sampling and measurement of particulate matters	1	CO1
3.2	Sampling and measurement of gaseous matters	1	CO1
3.3	Ambient air sampling, analysis of air pollutants- chemical and instrumental methods	1	CO1
3.4	Stack sampling	1	CO1

4.0	**Meteorological conditions**		CO2
4.1	Temperature lapse rate, stability	1	CO2
4.2	Adiabatic lapse rate, wind velocity and turbulence	1	CO2
4.3	Plume behaviour	1	CO2
4.4	Dispersion of air pollutants- maximum mixing depth, dispersion model	2	CO2
4.5	Gaussian plume model and plume rise- problems	2	CO2
5.0	**Reduction and control methods**		
5.1	Source reduction methods	1	CO3
5.2	Dilution by stack	1	CO3
5.3	Control by equipments - Particulate control methods	3	CO3
5.4	Control of gaseous emissions	3	CO3
5.5	Control of automotive pollution	1	CO3
5.6	Review of Journals	1	CO3
6.0	**Air pollution management**		
6.1	Zoning/City planning, Industrial plant location	1	CO4
6.2	Air quality and emission standards	1	CO4
6.3	Legal provision	1	CO4
7.0	**Noise pollution**		
7.1	Sound wave properties	1	CO5
7.2	Characteristics, sources & types of noise	1	CO5
7.3	Effects of noise, Noise rating system& Legal standards	1	CO5
7.4	Noise control techniques	1	CO6
	TOTAL	**36**	

Course Designers:

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2. K. Keerthy kkciv@tce.edu

22CEPP0	WASTE MANAGEMENT

CATEGORY	L	T	P	CREDIT
PSE	3	0	0	3

Preamble

This course provides an in-depth knowledge of various types of waste, their characteristics, technology and management for the safe disposal of waste generated by a community. This course will also highlight the economic feasibility, legal framework and viability of environmentally sustainable technologies for waste management.

Prerequisite

NIL

Course Outcomes

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

CONumber	Course Outcome Statement	TCE Proficiency scale	Expected Proficiency	Expected Attainment Level %
CO1	Explain the past, present status and environmental challenges in waste management	TPS2	A	65
CO2	Apply appropriate processing technologies for different types of waste	TPS3	A	65
CO3	Explore suitable operational model and safe disposal practices for different types of waste	TPS3	A	65
CO4	Analyse financial aspects of waste management.	TPS3	A	65
CO5	Suggest appropriate waste management approach for the waste related issues.	TPS3	A	65
CO6	Adopt the best practices in waste management To analyse of case studies for understanding success and failures	TPS3	A	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

CO	CAT1			CAT2			Terminal			ASSIGNMENT I			ASSIGNMENT II		
TPS Scale	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	10	10	-	-	-	-	2	5	-		30				
CO2	5	10	25	-	-	-	2	5	10			30			
CO3	5	10	25	-	-	-	2	5	10			40			
CO4	-	-	-	5	10	15	2	5	10	-	-	-	-	-	30
CO5	-	-	-	5	10	15	2	5	15	-	-	-	-	-	30
CO6	-	-	-	5	10	25	-	5	15	-	-	-	-	-	40

Syllabus

present status of Waste Management: Status of waste management-an overview, Sources and types of waste, Legislative framework and status of compliance for waste management, Governing bodies and organizational structure of responsible authorities, Environmental and Social challenges of Waste Management - case studies. **Technology for waste management:** Purpose of processing and processing technologies – an overview, Waste processing technologies for municipal solid waste, Biological conversion technologies, Thermal conversion technologies, Biomedical waste treatment process, Hazardous waste technologies options. **operational model for waste management:** Operational model for effective waste management, Extended producer Responsibility in waste management, Role of Informal sector in waste management, Techno-economic feasibility for Waste to Energy Plants, Automated waste management system, Future of waste energy plans in developing countries. **Financial aspects for waste management;** Economic aspects & Finance model for waste management, Cost recovery for waste management system, Financing mechanisms in IMSWM including circular financing, Total Cost Assessment, Public Private Partnership mode- Case studies. **Waste management approach:** Preventive environmental management, Waste minimization and 3R concept, Integrated waste management approach, Environmental management system- ISO14001, Life Cycle Assessment, Waste auditing-case studies. **Best practices in waste management:** Decentralized waste management, Concept of Net zero waste – Case studies, Best practices in entrepreneurship and innovations in MSWM, Patents relating to waste management in India, Case studies in different engineering disciplines, Best practices in waste management.

Learning Resources

1. George Tchobanoglous, Hilary Thiesen and Samuel A Vigil, “Integrated Solid Waste Management: Engineering Principles and Management Issues”, McGraw Hill Publishers, New York, 1993.
2. “Manual on Municipal Solid Waste Management”, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2016.
3. Bhide, A. D. and Sundaresan, B. B. “Solid Waste Management Collection, Processing and Disposal”, ISBN 81-7525-282-0, 2001.
4. Paul T Williams, “Waste Treatment and Disposal”, John Wiley and Sons, England, 2005.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.0 present status of Waste Management			
1.1	Status of waste management-an overview.	1	CO1
1.2	Sources and types of waste	1	CO1
1.3	Legislative framework and status of compliance for waste management	2	CO1
1.4	Governing bodies and organizational structure of responsible authorities	1	CO1
1.5	Environmental and Social challenges of Waste Management - case studies	1	CO1
2.0 Technology for waste management			
2.1	Purpose of processing and processing technologies – an overview	1	CO2
2.2	Waste processing technologies for municipal solid waste	1	CO2
2.3	Biological conversion technologies	1	CO2
2.4	Thermal conversion technologies	1	CO2
2.5	Biomedical waste treatment process	1	CO2
2.6	Hazardous waste technologies options	1	CO2
3.0 operational model for waste management			
3.1	Operational model for effective waste management	1	CO3

3.2	Extended producer Responsibility in waste management	1	CO3
3.3	Role of Informal sector in waste management	1	CO3
3.4	Techno-economic feasibility for Waste to Energy Plants	1	CO3
3.5	Automated waste management system	1	CO3
3.6	Future of waste energy plans in developing countries	1	CO3
4.0 Financial aspects for waste management			
4.1	Economic aspects & Finance model for waste management	2	CO4
4.2	Cost recovery for waste management system	1	CO4
4.3	Financing mechanisms in IMSWM including circular financing	1	CO4
4.4	Total Cost Assessment	1	CO4
4.5	Public Private Partnership mode- Case studies	1	CO4
5.0 Waste management approach			
5.1	Preventive environmental management	1	CO5
5.2	Waste minimization and 3R concept	1	CO5
5.3	Integrated waste management approach	1	CO5
5.4	Environmental management system- ISO14001	1	CO5
5.5	Life Cycle Assessment	1	CO5
5.6	Waste auditing-case studies	1	CO5
6.0 Best practices in waste management			
6.1	Decentralized waste management	1	CO6
6.2	Concept of Net zero waste – Case studies	1	CO6
6.3	Best practices in entrepreneurship and innovations in MSWM	1	CO6
6.4	Patents relating to waste management in India	1	CO6
6.5	Case studies in different engineering disciplines	1	CO6
6.6	Best practices in waste management	1	CO6
	TOTAL	**36**	

Course Designers:

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22CEPQ0	ENVIRONMENTAL IMPACT ASSESSMENT

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

Any developmental project will have impacts on the physical, social and biological environment. Some impacts are beneficial and some are adverse. EIA is important because it identifies the likely environmental, economical and social burden of the project at the initial phase of the project and informs the decision-makers about the significant impacts and risks associated with the project to promote sustainable development by ensuring the balance between environment and development.

Prerequisite

NIL.

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency scale	Expected Proficiency	Expected Attainment Level %
CO1	Explain the EIA process and categorize the EIA required for proposed projects	TPS2	A	70%
CO2	Apply the various methodologies involved in environmental Impact Assessment.	TPS3	A	70%
CO3	Predict and assess the impact of proposed projects on the Environment	TPS3	A	70%
CO4	assess the socio economic impacts on developmental projects	TPS3	A	70%
CO5	Propose proper mitigation measures to avoid environmental impact	TPS3	A	70%
CO6	Summarize the EIA report with suitable environmental management plan	TPS3	A	70%

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

CO	CAT1			CAT2			Terminal			ASSIGNMENT I			ASSIGNMENT II		
TPS Scale	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	10	10	-	-	-	-	2	5		-	30	-			
CO2	5	10	25	-	-	-	2	5	10			30			
CO3	5	10	25	-	-	-	2	5	10			40			-
CO4	-	-	-	5	10	15	2	5	10	-	-	-	-	-	30
CO5	-	-	-	5	10	15	2	5	15	-	-	-	-	-	30
CO6	-	-	-	5	10	25	-	5	15	-	-	-	-	-	40

Syllabus

Introduction: Impact of Development on Environment-Sustainable Development, Historical Development and Objectives of EIA,EIA Types & EIA in Project cycle, EIA notification & Legal framework in India. **Environmental Assessment:** Elements of EIA, Methods for Assessment – Applicability, Terms of Reference & Baseline monitoring ,Mathematical models for Impact Prediction, Prediction and Assessment of impact on Land and Water, Prediction and Assessment of impact on Air and Noise, Prediction and Assessment of impact on Flora and Fauna. **Socio Economic Impact Assessment:** SIA Planning Process , Baseline monitoring of Socio Economic environment, Public consultation , Issues related to the project affected people, Cost Benefit Analysis - Economic evaluation. **Environmental Management Plan:** Plan for the mitigation of impact on environment, Options for mitigation of Impact on Water ,Air, Noise and Land, Environmental Management Plan, Post project audit & Environmental audit, EIA report preparation -Generic structure, Quality aspects of EIA report-Environmental consultants. **Case Studies:** EIA for new & expansion projects, EIA for Building construction and area development projects, EIA for Infrastructure projects.

Learning Resources

1. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York, 1996.
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.	Topic	No. of Hours	Course Outcome
1.Introduction			
1.1	Impact of Development on Environment-need for Sustainable Development	1	CO1
1.2	Historical Development and Objectives of EIA	1	CO1
1.3	EIA Types & EIA in Project cycle	1	CO1
1.4	EIA notification & Legal framework in India	1	CO1
1.5	Stakeholders & their role in EIA,	1	CO1
2.Environmental Assessment			
2.1	Elements of EIA	1	CO2
2.2	Methods for Assessment-Applicability	2	CO2
2.3	Terms of Reference & Baseline monitoring	1	CO2
2.4	Appropriate methodology solution	1	CO2
2.5	Mathematical models for Impact Prediction	1	CO3
2.6	Prediction and Assessment of impact on Land and Water	2	CO3
2.7	Prediction and Assessment of impact on Air and Noise	2	CO3
2.8	Prediction and Assessment of impact on Flora and Fauna	1	CO3
3.Socio Economic Impact Assessment			
3.1	SIA Planning Process	2	CO4
3.2	Baseline monitoring of Socio Economic environment	1	CO4
3.3	Public consultation	1	CO4

3.4	Issues related to the project affected people	1	CO4
3.5	Cost Benefit Analysis - Economic evaluation	1	CO4
4.Environmental Management Plan			
4.1	Plan for the mitigation of adverse impact on environment	2	CO5
4.2	Options for mitigation of Impact on Water ,Air, Noise and Land.	2	CO5
4.3	Environmental Management Plan	1	CO5
4.4	Post project audit & Environmental audit	1	CO5
4.5	EIA report preparation -Generic structure.	1	CO6
4.6	Quality aspects of EIA report-Environmental consultants	1	CO6
5. Case Studies			
5.1	EIA for new & expansion projects	2	CO6
5.2	EIA for Building construction and area development projects.	2	CO6
5.3	EIA for Infrastructure projects	2	CO6

Course Designers:

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2. Dr. V. Ravi Sankar environmentengr@tce.edu

22CEPR0	BASICS OF REMOTE SENSING

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

The objective of this course is to provide knowledge on remote sensing of objects on the earth surface using EMR waves with its object response spectral characteristics. This course also highlight the types of platforms like satellites used for remote sensing with image processing techniques and multi level data integration through GPS for real world applications.

Prerequisite

Fundamental of Physics, Mathematics, Geography, Geology and Surveying

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected attainment level in %
CO1	Understand the fundamentals of radiation & EMR and its characteristics.	TPS2	A	70
CO2	Understand various types of platforms and sensors used for remote sensing.	TPS2	A	70
CO3	Understand the process of image processing and interpretation techniques.	TPS2	A	70
CO4	Apply knowledge of satellites on various Civil Engineering applications	TPS3	A	70
CO5	Illustrate multi level data integration methods for mapping	TPS3	A	70
CO6	Apply knowledge of GPS for real time scenarios	TPS3	A	70

*** Weightage depends on Bloom's Level, number of contact hours.

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	15	20	-	-	-	-	-	-	-	-	-	-	4	6	-	-	-	-	-	-	35	-	-	-	-	-	-	-	-	-
CO2	10	20	-	-	-	-	-	-	-	-	-	-	4	6	-	-	-	-	-	-	35	-	-	-	-	-	-	-	-	-
CO3	10	20	-	-	-	-	-	-	-	-	-	-	4	6	-	-	-	-	-	-	30	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	10	10	15	-	-	-	4	6	10	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO5	-	-	-	-	-	-	10	10	15	-	-	-	4	6	20	-	-	-	-	-	-	-	-	-	-		20	-	-	-
CO6	-	-	-	-	-	-	5	10	15	-	-	-	4	6	10	-	-	-	-	-	-	-	-	-	-		40	-	-	-

Syllabus

Introduction and Basic Concepts of Remote Sensing–Sources - EMR spectrum - Radiation Principles **Remote Sensing systems**- 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 Resolutions of Satellites**– IRS series – IKONOS, CARTOSAT – RESOURCESAT, Quickbird, OrbView, GeoEye, WorldView. **Global Positioning System**– Introduction– Concept - Segment - Positioning – Methods – Accuracy-GPS integration.

Learning Resources

1. Lillesand, Thomas, Ralph W. Kiefer, and Jonathan Chipman. Remote sensing and image interpretation, John Wiley & Sons, 2014.
2. Hofmann-Wellenhof, B., Lichtenegger, H., & Collins, J. Global positioning system: theory and practice, Springer Science & Business Media, 2012.
3. Jensen, John R. Remote sensing of the environment: An earth resource perspective 2nd edition, Pearson Education India, 2009.
4. Campbell, James B., and Randolph H. Wynne. Introduction to remote sensing. Guilford Press, 2011.
5. El-Rabbany, A. Introduction to GPS: the global positioning system, Artech House, 2002.
6. Gopi, S. Global positioning System: Principles and applications, Tata McGraw-Hill Education, 2005.
7. NPTEL: https://nptel.ac.in/courses/105103193/
8. IIRS.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction and basic concepts of Remote Sensing**		
1.1	Definitions and Energy sources	1	CO1
1.2	EMR spectrum –wavelength and frequency, regions and its properties	1	CO1
2.	Radiation laws – Plank's, Stefen, Kirchhoff's law and Boltzman law, radiant and kinetic temperature	1	CO1
2.1	Black body radiation	1	CO1
2.2	**Remote Sensing systems**		
2.3	Scattering – Rayleigh, Mie and Non-selective scattering	1	CO1
2.4	Reflection and absorption – types of reflecting surfaces and variations in absorption level by various objects and its controlling factors	1	CO1
2.5	Atmospheric windows and its significance	1	CO1
3.	Interaction of energy with atmosphere - Scattering, absorption, transmission, atmospheric windows	1	CO1
3.1	Interaction of energy with terrain – water, ice, vegetation, soils, minerals and rocks.	1	CO1
3.2	Spectral reflectance and concept of signature	1	CO3
	Spectral signature and curve	1	CO3
3.3	Data Processing	1	CO3
4.	**Remote Sensing Data Scanning Systems**		
4.1	Platforms - Ground, Airborne and Space borne	1	CO2

4.2	Orbital Characteristics – Coverage, Passes, Pointing Accuracy, Geostationary, sun synchronous, shuttle orbit. Semisynchronous orbit (Molniya orbit) and Quasi - zenith satellite orbit	1	CO2
4.3	Whiskbroom scanners, Pushbroom scanners, Side looking scanners, Multi and Hyperspectral scanners.	1	CO2
4.4	Types and Characteristics of Sensors - Imaging and non - imaging sensors, Active and passive sensors	1	CO2
5.	**Sensor Resolutions of Satellites**		
5.1	Spectral, Spatial, Radiometric & Temporal resolutions	2	CO2
5.2	IRS series – IRS – 1A and IRS – 1B sensors resolutions	1	CO2
	IRS series – IRS – 1C and IRS – 1D sensors resolutions	1	CO2
5.3	OCEANSAT – CARTOSAT – RESOURCESAT sensors resolutions	1	CO3
5.4	Sensors resolutions of IKONOS, Quickbird, OrbView, GeoEye, WorldView	1	CO3
5.5	Other important earth and space imaging satellite sensors resolutions	1	CO3
	Global Positioning System		
5.6	Introduction to GPS, Reference Systems and Coordinate systems: Geodetic coordinate systems, Datum transformations, Height systems, Time systems	2	CO6
5.7	Satellite Navigations constellations and Geopositioning	2	CO6
6.	Global Positioning Systems		
6.1	Basic Concepts - NAVSTAR, GLONASS, Indian Regional navigational Satellite System (IRNSS)	1	CO6
6.2	Control Segment, Space Segments, User Segment	2	CO6
6.3	GPS Positioning Types-Absolute Positioning, Differential positioning.	2	CO6
6.4	GPS Surveying Methods and Accuracy - Static & Rapid Static, Kinematic-Real Time Kinematic Survey –DGPS-GPS Data Processing and Accuracy	2	CO6
6.5	GPS integration- GPSLRF, GPSINS, GPS pseudolite, cellular integration.	2	CO5

Course Designers:

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CATEGORY	L	T	P	CREDIT
PSE	3	0	0	3

22CEPS0	GROUND WATER MANAGEMENT

Preamble

The objective of this course is to introduce the principles, methods and practices of well hydraulics and concept of ground water management. It also emphasise the need for protecting ground water resources from contamination and 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

CO Number	Course Outcome Statement	TCE Proficiency scale	Expected Proficiency	Expected Attainment Level %
CO1	Explain the origin and occurrence of ground water	TPS3	80	B
CO2	Plan and develop ground water resources	TPS3	80	B
CO3	Understand the properties and types of aquifers	TPS3	80	B
CO4	Estimate the yield from aquifers through pumping test	TPS3	80	B
CO5	Apply the artificial Recharge techniques	TPS3	80	B
CO6	Formulate Strategies to control the ground water pollution	TPS3	80	B

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	10	10	10	-	-	-	-	-	-	-	-	-	2	6	10	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO2	5	10	15	-	-	-	-	-	-	-	-	-	2	12	-	-	-	-	-	-	30		-	-	-	-	-	-	-	-
CO3	5	10	20	-	-	-	-	-	-	-	-	-	2	6	10	-	-	-	-	-	30		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	15	10	-	-	-	2	12	-	-	-	-	-	-	-	-	-	-	-		30	-	-	-
CO5	-	-	-	-	-	-	5	10	15	-	-	-	2	6	10	-	-	-	-	-	-	-	-	-	-		30	-	-	-
CO6	-	-	-	-	-	-	5	15	20	-	-	-	2	6		-	-	-	-	-	-	-	-	-	-		40	-	-	-

Syllabus

Ground water Occurrence: Origin of ground water, hydrologic cycle, rock properties effecting ground water, vertical distribution of ground water, zone of aeration and zone of saturation. **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. **Aquifers:** Geologic formation, types, porosity, Specific yield and Specific retention. **Analysis of Pumping Test :** Steady ground water flow towards a well in confined and unconfined aquifers, Dupit's and Theim'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. **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.

Learning Resources

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)
3. Groundwater system planning & management- R.Willies&W.W.G.Yeh,Printice Hall (1987).
4. Apply Hydrogeology by C.W.Fetta, CBS Publishers & Distributers (2019).

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.0	**Ground water Occurrence**		
1.1	Origin of ground water	1	CO1
1.2	Hydrologic cycle	1	CO1
1.3	Rock properties effecting ground water	1	CO1
1.4	Vertical distribution of ground water, zone of aeration and zone of saturation	1	CO1
2.0	**Planning of Ground water Development**		
2.1	Water balance	1	CO 2
2.2	assessment of recharge	1	CO 2
2.3	utilizable recharge	1	CO 2
2.4	Indian practices, constraints on ground water development	1	CO 2
2.5	Feasibility check, optimal ground water developments	1	CO 2
2.6	Planning of ground water development in canal command areas	2	CO 2
2.7	Planning of ground water development in coastal aquifers	1	CO 2
3.0	**Aquifers**		
3.1	Geologic formation and types	1	CO 3
3.2	Aquifer Properties : porosity, Specific yield and Specific retention	1	CO 3
4.3	**Analysis of Pumping Test**		
4.1	Steady ground water flow towards a well in confined aquifers	2	CO 3
4.2	Steady ground water flow towards a well in unconfined aquifers	2	CO 3
4.3	Dupit's and Theim's equations	2	CO 4
4.4	Cooper and Jacob Method	2	CO 4
5.0	**Artificial Recharge of Ground Water**		

5.1	Concept of artificial recharge	1	CO 5
5.2	Recharge methods	1	CO 5
5.3	Relative merits of artificial recharge	1	CO 5
5.4	Application of GIS in artificial recharge of Ground Water	3	CO 5
5.5	Remote sensing in Artificial Recharge of Ground Water.	3	CO 5
6.0	**Control of Ground Water Pollution Hazards**		
6.1	Evaluation of pollution hazard	2	CO 6
6.2	water supply pollution hazards	1	CO 6
6.3	Strategies for control of ground water pollution	1	CO 6
6.4	Mounting Ground Water Quality Protection Programs	1	CO 6
	TOTAL	**36**	

Course Designers:

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22CEPT0	ENGINEERING HYDROLOGY

Category	L	T	P	Credit
PSE	2	1	0	3

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.

Prerequisite

Fundamentals of Engineering Mathematics and Basic Science.

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Demonstrate the importance of hydrological cycle and make the measurement of rainfall data.	TPS3	A	70
CO2	Compute the losses viz evaporation, evapotranspiration and infiltration for a catchment area.	TPS3	A	70
CO3	Calculate the quantity of runoff generated from a catchment.	TPS3	A	70
CO4	Illustrate the hydrographs to measure the stream flow.	TPS3	A	70
CO5	Compute flood flows and use suitable control measures.	TPS3	A	70
CO6	Suggest methods of conserving surface and groundwater.	TPS2	A	70

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	8	10	25	-	-	-	-	-	-	-	-	-	2	5	25	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO2	4	10	5	-	-	-	-	-	-	-	-	-	-	5	5	-	-	-	-	-	20		-	-	-	-	-	-	-	-
CO3	8	10	20	-	-	-	-	-	-	-	-	-	2	5	10	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	5	30	-	-	-	2	5	10	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-
CO5	-	-	-	-	-	-	5	10	20	-	-	-	2	5	10	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-
CO6	-	-	-	-	-	-	10	15	-	-	-	-	2	5	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-

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**. Runoff and Hydrograph:** 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 surface float and current meters. **Floods and Routing**: Definition, Flood estimation and its control and Muskingum method of flood routing. **Ground water:** Definition, Properties and types of aquifers, Aquifer parameters, Steady flow into a well for confined and unconfined flow, Methods of artificial recharge.

Learning Resources

1. Subramanya.K., Engineering Hydrology, Tata McGraw Hill, New Delhi, 2013
2. Jayarami Reddy. Hydrology, Tata McGraw Hill, New Delhi, 2011.
3. Ragunath.H. Hydrology, Wiley Eastern Limited, New Delhi, 2010.
4. VenTe. Chow, Maidment D.R. and Mays L.W. Applied Hydrology, McGraw Hill International Book Company New York, 1995.
5. VenTe Chow, Hand book of Applied Hydrology, McGraw Hill Book Co., Inc., New York, 1964.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	Course Outcome
1	**Hydrologic processes**		CO1
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	
	Tutorial	1	
1.6	Rainfall hyetograph, Rainfall mass curve, Double mass curve techniques.	1	
	Tutorial	1	
1.7	Estimation and measurement of Evaporation	2	CO2
	Tutorial	1	
1.8	Estimation and measurement of Evapotranspiration	1	

1.9	Estimation and measurement of Infiltration	1	
2	**Runoff and Hydrograph**		
2.1	Definition of runoff, factors affecting runoff and its components	1	CO3
2.2	Hydrograph analysis, Components of hydrograph, Methods of base flow separation,	1	
	Tutorial	1	
2.3	Unit hydrograph theory	1	CO4
	Tutorial	2	
2.4	Stream flow measurements using surface float and current meters	1	
	Tutorial	2	
3	**Floods and Routing**		CO5
3.1	Definition of flood and estimation of flood	2	
3.2	Flood control measures	1	
3.3	Muskingum method of flood routing	1	
	Tutorial	2	
4	**Ground water**		CO6
4.1	Definition, Properties and types of aquifers, Aquifer parameters	1	
4.2	Steady flow into a well for confined flow	1	
4.3	Steady flow into a well for unconfined flow	1	
	Tutorial	2	
4.4	Methods of artificial recharge.	1	
	Total Hours(24Hrs+12Hrs)	**36**	

Course Designers:

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22CEPU0	GROUND IMPROVEMENT TECHNIQUES

Category	L	T	P	Credit
PC	3	0	0	3

Preamble

This course deals with the different methods adopted for improving the properties of remoulded and in-situ soils by techniques such as in- situ densification, consolidation and dewatering. This course enables the graduates to understand how reinforced earth walls can obviate the problems associated with conventional retaining walls. Also, the graduates are exposed to the concepts of grouting, soil stabilization and the use of geotextiles to improve the engineering performance of soils.

Prerequisite

Soil Mechanics and Foundation Engineering

Course Outcomes

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

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Understand the role of ground improvement and select appropriate ground improvement technique for the given subsoil condition.	TPS2	A	65
CO2	Suggest appropriate dewatering technique for lowering the ground water table	TPS3	A	65
CO3	Recommend suitable techniques for densifying cohesionless soil deposits	TPS3	A	65
CO4	Suggest appropriate techniques for improving cohesive soil deposits	TPS3	A	65
CO5	Perform simple design of reinforced earth walls and illustrate the role of geo-textile in ground improvement	TPS3	A	65
CO6	Explain the concept of grouting and soil stabilization for improving the engineering performance of soils.	TPS2	A	65

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Assessment	CAT1			CAT2			Terminal Exam			Assignment 1			Assignment 2		
TPS / COs	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	4	16	-	-	-	-	2	15	-	-	30	-	-	-	-
CO2	4	9	28	-	-	-	2	-	15	-	-	30	-	-	-
CO3	4	8	27	-	-	-	2	-	16	-	-	40	-	-	-
CO4	-	-	-	3	3	27	2	-	16	-	-	-	-		30
CO5	-	-	-	3	16	28	2	-	16	-	-	-	-		40
CO6	-	-	-	4	16	-	2	10	-	-	-	-	-	30	-

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 Soils:** In-situdensificationofcohesion-lesssoils:DynamicCompaction-vibroflotation,sandcompactionpiles - deep compaction. **Insitu Treatment of Cohesive Soils:** 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 and geotextiles **Grouting 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 Book

1. Purushothama Raj. P, "Ground Improvement Techniques", Laxmi Publications (P) Ltd, New delhi,2019.

Reference Books & Web Resources

1. Mittal.S, "An Introduction to Ground Improvement Engineering", Medtech Publisher, 2013.
2. NPTEL Materialhttps://nptel.ac.in/courses/105108075/

IS Code for Practice

- IS9759: 1981 "Guidelines for Dewatering During Construction", Bureau of Indian Standards, New Delhi, Reaffirmed1999.
- 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.	Topic	No. of Hours	Course Outcome
1.	**Problematic Soil and Improvement Techniques**		
1.1	Role of ground improvement in foundation engineering	2	CO1
1.2	methods of ground improvement – Geotechnical	2	
1.3	Selection of suitable ground improvement techniques	2	

2.	**Dewatering**		
2.1	Necessity of dewatering – sumps and interceptor ditches.	2	CO2
2.2	Single and multi-stage well points	2	
2.3	Deep well – vacuum well points – electro osmosis	2	
2.4	Criteria for choice of filler material around drains	2	
3.	**Insitu Treatment of Cohesionless Soils**		
3.1	In-situ densification of cohesion-less soils: Dynamic Compaction – vibroflotation.	2	CO3
3.2	Sand compaction piles – deep compaction.	2	
4.	**Insitu Treatment of Cohesive Soils**		
4.1	Consolidation: Preloading with sand drains – fabric drains, stone columns – Lime piles – installation techniques	2	CO4
4.2	Relative merits of above methods and their limitations.	2	
5.	**Earth Reinforcement and Geotextiles**		
5.1	Concept of reinforcement – types of reinforcement material	2	CO5
5.2	Reinforced earth wall – Mechanism – simple design	2	
5.3	Applications of reinforced earth and geotextiles	2	
6.	**Grout Techniques and Soil Stabilization**		
6.1	Objectives of grouting – types of grouts	2	CO6
6.2	Grouting Equipments and machinery – injection methods	2	
6.3	Grout monitoring	1	
6.3	Stabilization with cement, lime and chemicals	2	
6.4	Stabilization of expansive soil.	1	
	Total Hours	**36**	

Course Designer(s):

1. Dr. R.SanjayKumar sanjaykumar@tce.edu

22CEPV0	TRAFFIC ENGINEERING ANDSAFETY

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

Studentswillacquirecomprehensiveknowledgeoftrafficsurveysandstudiessuchasvolume count, Speed and delay, origin and destination, parking, pedestrian and accident surveys. Theywillachieveknowledgeondesignofintersections.Studentswillbecomefamiliarwith various traffic control and traffic management measures.

Prerequisite

Fundamentals of Highway Engineering

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Explain road user and vehicular characteristics	TPS3	B	65
CO2	Apply the knowledge of traffic surveys in traffic management	TPS3	B	65
CO3	Design geometrics of intersections	TPS3	B	65
CO4	Apply the methods of traffic control aids in road network	TPS3	B	65
CO5	Explain the rules and regulations of road safety	TPS2	B	65
CO6	Adapt a suitable road safety management technique for congested traffic pattern	TPS3	B	65

*** Weightage depends on Bloom's Level, number of contact hours,

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern:

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	4	20		-	-	-	-	-	-	-	-	-	2	-	10	-	-	-	-	-	20		-	-	-	-	-	-	-	-
CO2	4	30		-	-	-	-	-	-	-	-	-	2	2	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3		12	30	-	-	-	-	-	-	-	-	-	2	2	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	4	4	30	-	-	-	2	2	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO5	-	-	-	-	-	-	4	-	20	-	-	-	2	-	10	-	-	-	-	-	-	-	-	-	-		20	-	-	-
CO6	-	-	-	-	-	-	4	4	30	-	-	-	2	2	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-

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-** Definition, Objectives, Road safety demographics, Traffic regulations – basic principles, National Road Safety Policy, Motor Vehicle Act–1988, Intersection safety, driving in night times, long journey, road safety at road works. **Traffic management systems -** methods and techniques for traffic management**-**role of ITS in traffic management

Learning Resources

1. KadiyaliL.R,“TrafficEngineeringandTransportationPlanning”KhannaPublishers, Delhi, 2005.
2. KhannaSKandJustoCEG,“HighwayEngineering”,NemChand&Bros,Roorkee,2010.
3. MikeSlinn,PeterGuestandPaulMatthews“TrafficEngineeringDesignPrinciplesandPractice”,Elesevier,2006. Onlinecourses
4. https://nptel.ac.in/courses/105101008/
5. https://www.crridom.gov.in/content/traffic-engineering-and-safety

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	Course Outcome
1.0	**Introduction**		
1.1	Significance and scope, Characteristics of Driver,	1	CO1
1.2	Pedestrian, the vehicle and road	1	
1.3	Skid resistance and braking efficiency	1	
2.0	**Traffic Surveys and Analysis**		
2.1	Surveys for Traffic Engineering, Speed studies	2	CO2
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)	2	
3.0	**Geometric Design of intersection**		
3.1	Conflict points at intersections	1	CO3
3.2	Principles and elements of intersection design	1	
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	CO4
4.2	Design of traffic signal and signal coordination.	2	
4.3	Traffic control aids -Types of street furnitures	1	
4.4	Street lighting – Purpose, importance	2	
5.0	**Road safety**		
5.1	Definition, Objectives, Road safety demographics	1	CO5
5.2	Traffic regulations – basic principles, National Road Safety Policy, Motor Vehicle Act – 1988	1	
5.3	Intersection safety, driving in night times, long journey,	2	

	road safety at road works		
6.0	**Transportation System Management**		
6.1	Methods of Travel demand & traffic management	3	CO6
6.2	Role of ITS in traffic management	2	
	Total Hours (24 Hrs+12 Hrs)	36 Hrs	

Course Designers:

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22CEPW0	AIRWAYSANDWATERWAYS

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

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

CO	Course Outcome Statement	TCE Proficiency Scale	Attainment level	Proficiency level
CO1	Understand the basics of airport planning and its importance in national development	TPS2	A	70
CO2	Design various components of airports	TPS3	A	70
CO3	Geometric Design and Corrections for Gradients	TPS2	A	70
CO4	Air-traffic control aids on airport	TPS2	A	70
CO5	Gain knowledge on harbour and docks and its functions	TPS2	A	70
CO6	Select the suitable types of navigational aids	TPS2	A	70

*** Weightage depends on Bloom's Level, number of contact hours,

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern:

CO	CAT1			CAT2			Terminal			Assignment 1			Assignment 2		
TPS Scale	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	4	20	-	-	-	-	2	10		-	2	-	-	-	-
CO2	4	6	30	-	-	-	2	2	15	-	-	40	-	-	-
CO3	6	30		-	-	-	4	15	-	-	4		-	-	-
CO4	-	-	-	4	3	4	4	15	-	-	-	-	-	40	-
CO5	-	-	-	4	2	4	2	10	-	-	-	-	-	20	-
CO6	-	-	-	4	3	4	4	15	-	-	-	-	-	40	-

Syllabus

Airport planning: Role of air transport - Components of airports- Airport Planning, Site Selection **Design of Airport components:** Runway Design - Orientation, Cross wind Component, Wind rose Diagram, **Geometric Design and Corrections for Gradients** : 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 Concepts. **Visual aids and Air Traffic Control:** Airport marking and lighting-Need of Air Traffic Control-Air Traffic Control Network-Air Traffic control Aids. **Harbours and Docks :** 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, Range of Tides, Waves and Tidal Currents, Anchoring Grounds, Geological Characteristics, Shore Considerations - Proximity to Towns/Cities, Utilities, – Coastal Structures- Breakwaters, Wharves- Dry and Wet Docks, Planning and Layouts, **Navigational aids and dredging:** Navigating - Mooring Accessories, Navigational Aids-Dredging

Learning Resources

1. Khanna.S.K. Arora.M.G and Jain.S.S, Airport Planning and Design, Nem Chand and Bros ,Roorkee,6th Edition, 2009.
2. S P Bindra, A Course in Docks and Harbour Engineering, Dhanpat Rai and Sons,New Delhi,2012.
3. Rangwala, Airport Engineering, Charotar Publishing House, 2016.
4. Rao G.V., Airport Engineering, Tata Mc Graw Hill, New Delhi, 1992.
5. Seetharaman, “Dock & Harbour Engineering”, 1st Edition, Umesh Publications, 2008.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	Course Outcome
1.0	**Airport planning**		
1.1	Role of Air Transport, Components of Airports	1	CO1
1.2	Airport Planning – Air traffic potential, Site Selection	2	
2.0	**Design of Airport components**		
2.1	Runway Design- Orientation, Cross wind Component, Wind rose Diagram	**3**	CO2
3.0	**Geometric Design and Corrections for Gradients**		
3.1	Taxiway Design – Geometric Design Elements, Minimum Separation Distances, Design Speed	2	CO3
3.2	Airport Drainage - Airport Zoning - Clear Zone, Approach Zone, Buffer Zone, Turning Zone, Clearance over Highways and Railways	2	
3.3	Airport Layouts – Apron, Terminal Building, Hangars,Motor Vehicle Parking Area and Circulation Pattern,	1	
3.4	Airport Buildings – Primary functions, Planning Concept,Principles of Passenger Flow, Passenger Facilities	1	
3.5	Taxiway Design – Geometric Design Elements,Minimum Separation Distances, Design Speed	2	
4.0	**Visual aids and Air Traffic Control**		
4.1	Visual Aids - Runway and Taxiway marking, Wind Direction Indicators, Runway and Taxiway Lightings.	2	CO4
4.2	Air Traffic Control – Basic Action, Air Traffic Control Network- Control within terminal area, Control over airways, Airway Communication	2	

4.3	Air Traffic control Aids - Enroute aids and landing aids, Helipads, Hangars, Service Equipments	2	
5.0	**Harbour and Docks**		
5.1	Definition of Terms - Harbours, Ports, Docks, Tides and Waves, Littoral Drift, Sounding, Area, Depth	2	CO5
5.2	Satellite Ports - Requirements and Classification of Harbours – Site Selection	2	
5.3	Selection Investigation – Speed of water, Range of Tides, Waves and Tidal Currents, Littoral Transport with Erosion and Deposition	2	
5.4	Shore Considerations- Proximity to Towns/Cities, Utilities, Coastal Structures – Breakwaters, Wharves	2	
5.5	Dry and Wet Docks, Planning and Layouts - Entrance	3	
6.0	**Navigational aids and Dredging**		
6.1	Necessity and types of signals including floating signals – buoys and beacons- mooring and mooring accessories	3	CO6
6.2	Types of dredging and its applications.	2	
	Total Hours	36 Hrs	

Course Designers:

1. Dr. R. Velkennedy rvkciv@tce.edu
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22CEPX0	GEOTECHNIQUES FOR INFRASTRUCTURE

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

Major Infrastructures like bridges, tunnels, Transmission line Towers etc require the use of special Foundations. Often foundations for these works are constructed in poor soils which require remediation work like the use of geo textiles. This course deals with the methods of construction of raft foundation, piles, caissons, diaphragm walls, Foundation for Transmission Towers, Chimneys etc. Also, techniques for the construction of Foundations in Expansive soils, Compressible soils and Drainage and Dewatering methods for the construction of Foundations are addressed.

Prerequisite

Soil Mechanics and Foundation Engineering

Course Outcomes

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

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Suggest appropriate construction methods for Rafts and Diaphragm walls.	TPS3	A	65
CO2	Suggest suitable construction methods for Foundation for Transmission line Towers and Pile Foundations.	TPS3	A	65
CO3	Recommend the safety measures to be adopted during piling, sinking of Caissons and explain the concept of reinforced earth walls	TPS3	A	65
CO4	Suggest suitable Foundation Techniques for Expansive soils and Compressible soils.	TPS3	A	65
CO5	Justify the application of geotextiles in construction works	TPS3	A	65
CO6	Suggest suitable construction methods for drilled pier and explain the concept of piled raft.	TPS3	A	65

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Assessment	CAT 1			CAT 2			Terminal Exam			Assignment 1			Assignment 2		
TPS / COs	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	4	4	30	-	-	-	2	-	15	-	-	30	-	-	-
CO2	3	3	20	-	-	-	2	-	12	-	-	30	-	-	-
CO3	3	3	30	-	-	-	2	-	15	-	-	40	-	-	-
CO4	-	-	-	3	3	27	2	-	15	-	-	-	-		30
CO5	-	-	-	3	-	28	2	-	15	-	-	-	-		40
CO6	-	-	-	4	16	16	-	10	8	-	-	-	-		30

Syllabus

CONSTRUCTION OF SHALLOW FOUNDATIONS: Excavations for Foundations in soft soils – Recommendations – Types of Raft - Construction of Raft Foundations – Foundations for Transmission line towers and poles – Construction of Diaphragm walls –. **CONSTRUCTION OF DEEP FOUNDATIONS:** Selection of appropriate type of Pile – Piling rig – Pile driving hammers - Construction aspects of bored and driven Piles – Micro Piles – Pile groups – Berthing structures and Jetties – Codal provisions. **CONSTRUCTION SAFETY:** Safety measures during piling – sinking of Caissons - **EARTH REINFORCEMENT:** Earth reinforcement – Principles and basic mechanism of reinforced earth–Construction of reinforced earth retaining walls. **FOUNDATIONS ON WEAKSOILS:** Soil improvement and Foundation Techniques for compressible and expansive soils. **GEOTEXTILES:** Synthetic and natural fiber - based Geotextiles and their applications - Filtration, drainage, separation, erosion control. **DRILLED PIER AND PILED RAFT:** Types of drilled shafts - construction procedure-load bearing capacity in sand and clay-Types of piled raft - Design of piled raft for settlement reduction and load transmission.

Text Book

1. Das, B.M., Principles of Foundation Engineering, Sixth Edition, India Edition, Thomson,2007.

Reference Books&Web Resources

1. Hans–George Kempfert & Berhane Gebreselassie., “Excavation and Foundations in soft soils”, Springer.
2. Murthy, V.N.S., “Advanced Foundation Engineering”, CBS Publishers & Distributors, New Delhi,2015.
3. Purushothama Raj, P., “Ground Improvement Techniques”, Laxmi Publications (P) Ltd., New Delhi,2015
4. Tomlinson M.J., “Pile Design and Construction Practice”, Fourth Edition, E & FN SPON an imprint of Chapman & Hall.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hour	Course Outcome
1	**CONSTRUCTION OF SHALLOW FOUNDATIONS**		
1.1	Excavations for Foundations in soft soils -	2	CO1
1.2	Types of Raft - Construction of Raft Foundations	1	
1.3	Foundations for Transmission line towers and poles	2	
1.4	Construction of Diaphragm walls	1	
2.	**CONSTRUCTION OF DEEP FOUNDATIONS**		
2.1	Selection of appropriate type of Pile – Piling rig – Pile driving hammers	2	CO2
2.2	Construction aspects of bored and driven Piles – Micro Piles – Pile groups	2	
2.3	Berthing structures and Jetties – codal provisions	1	
3.	**CONSTRUCTION SAFETY**		
3.1	Safety measures during piling	2	CO3
3.2	Sinking of Caissons	2	
4.	**EARTH REINFORCEMENT**		
4.1	Earth reinforcement – Principles and basic mechanism of reinforced earth	2	CO3
4.2	Construction of reinforced earth retaining walls	2	
5.	**FOUNDATIONS ON WEAK SOILS**		
5.1	Soil improvement	2	CO4
5.2	Foundation Techniques for compressible	2	
5.3	Foundation Techniques for expansive soils	1	
6.	**GEOTEXTILES**		
6.1	Synthetic and natural fiber-based Geotextiles	1	CO5
6.2	Application of Geotextiles - Filtration, drainage	2	
6.3	Separation - erosion control	2	
7.	**DRILLED PIER AND PILED RAFT**		
7.1	Types of drilled shafts	1	CO6
7.2	Construction procedure for drilled pier	2	
7.3	Load bearing capacity in sand and clay	1	
7.4	Types of piled raft	1	
7.5	Design of piled raft for settlement reduction and load transmission.	2	
	Total Hours	**36**	

Course Designer(s):

1. Dr. R.SanjayKumar sanjaykumar@tce.edu

22CERA0	ASEISMIC DESIGN OF STRUCTURES

Category	L	T	P	Credit
PEES	3	0	0	3

Preamble

This course offers design of structures subjected seismic forces. This also includes Design concepts of seismic Hard analysis

Prerequisite

Static and Dynamics

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Apply the SHA to evaluate seismic hazard parameters	TPS3	B	65
CO2	Apply theory of vibration to the built structures for Random vibration	TPS3	B	65
CO3	Evaluate Liquefaction potential and suggest the methods to overcome liquefaction	TPS3	B	65
CO4	Apply the Indian codal provisions to analyse the RC structures and masonry buildings	TPS3	B	65
CO5	Apply the Indian codal provisions to design a shear wall	TPS3	B	65
CO6	Apply the vibrating principles to Design the foundation for EQ forces	TPS3	B	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	-	25	-	-	-	-	-	-	-	-	-	1	-	13	-	-	-	-	-	30		-	-	-	-	-	-	-	-
CO2	5	10	25	-	-	-	-	-	-	-	-	-	2	6	13	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	5	-	25	-	-	-	-	-	-	-	-	-	2	-	13	-	-	-	-	-	30		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	10	25	-	-	-	2	6	13	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-
CO5	-	-	-	-	-	-	5	-	25	-	-	-	2	-	13	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-
CO6	-	-	-	-	-	-	5	-	25	-	-	-	1	-	13	-	-	-	-	-	-	-	-	-	-		30	-	-	-

Syllabus

Introduction - Indian Seismology – Earth Quake History Deterministic Seismic Hazard Analysis (DSHA) Probabilistic Seismic hazard Analysis (PSHA) **Random Vibration** Response by Duhamel integral and Laplace transform method- Response of the structure to random vibrations and repeated loading - Response of the structure to random vibration Tripartite response spectra problems - **Liquefaction Dynamic** Soil properties Field and Lab tests-soil structure interaction Problems on Liquefaction evaluation -Cyclic stress approach – Seed and Idriss method – Measures to overcome Liquefaction **Analysis of RC structures for seismic forces** -Seismic coefficient and Response spectrum method -Analysis of stresses in masonry piers-Seismic forces evaluation for torsional eccentricity -**Shear Wall** Design of shear wall – Khan and Saboronis method -Coupled shear wall system – Rosman's method - **Machine Foundations** Design of foundation for EQ forces -MSD Model - EHS theory - Tschebotarioff's reduced natural frequency method

Reference Books

1. Anil.K.Chopra,"Dynamics of Structures" (Theory and Applications to Earthquake Engineering), Prentice Hall of India Private Limited, 2nd Edition, New Delhi, 2003.
2. Clough R W and Penzien J, "Dynamics of structures", McGraw Hill
3. Jaykrishna, "Elements of earthquake engineering" , Saritha Prakasan, Naunchandi, Meerut.
4. Mukhopadhyay, M., "Structural Dynamics", Ane Books, India, 2006
5. Pankaj Agarwal and Manish Shrikandhe, "Earthquake Resistant Design of Structures", PHI.
6. Park & Paulay, "Reinforced concrete", McGraw-Hill.

List of national and international Standard Codes

1. IS 1893 (Part-1):2016- Criteria for Earthquake resistant design of structures
2. IS 13935: 2009 – Seismic evaluation, repair and strengthening of masonry buildings — guidelines
3. IS 4326:1993 - Earthquake resistant design and construction of buildings — code of practice
4. IS 13827:1993 - Improving earthquake resistance of earthen buildings — guidelines
5. IS 13828:1993 - Improving earthquake resistance of low strength masonry buildings — guidelines
6. IS 13920:2008-Ductile detailing of Reinforced Concrete Structures subjected to Seismic Forces-Code of Practise

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures
1.0	**Introduction**	
1.1	Indian Seismology	1
1.2	Deterministic Seismic hazard Analysis (DSHA)	2
1.3	Probabilistic Seismic hazard Analysis (PSHA)	2
2.0	**Random Vibration**	
2.1	Response by Duhamel integral	1
2.2	Laplace transform method	1
2.3	Response of the structure to random vibrations and repeated loading	2
2.4	Response of the structure to random vibration	2
2.5	Tripartite response spectra	1
3.0	**Liquefaction**	
3.1	Dynamic Soil properties Field and Lab tests	2

3.2	Liquefaction Problems on Liquefaction evaluation	2
3.3	Cyclic stress approach –Seed and Idriss method	1
3.4	Measures to overcome Liquefaction	1
4.0	**Analysis of RC structures for seismic forces**	
4.1	Introduction to IS 1893 Part I : 2016	1
4.2	Seismic coefficient method	1
4.3	Response spectrum method	2
4.4	Seismic forces evaluation for torsional eccentricity	2
4.5	Analysis of stresses in masonry piers	1
5	**Shear Wall**	
5.1	Introduction ,Types of shear wall	1
5.2	Location of shear wall in RC structures	2
5.3	Design of shear wall as per IS 13920 codal provisions	2
5.4	Khan and Saboronis method	1
5.5	Coupled shear wall system – Rosman's method	1
6	**Machine Foundations**	
6.1	Dynamic soil properties	1
6.2	MSD Model	1
6.3	EHS theory	1
6.4	Tschebotarioff's reduced natural frequency method	1
	Total Hours	**36**

Course Designers:

1. Dr.R.Ponnudurai rpdciv@tce.edu
2. Mr. R.Indrajithkrishnan jith@tce.edu

22CERB0	EXPERIMENTAL TECHNIQUE AND INSTRUMENTATIONS

Category	L	T	P	Credit
PEES	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, Strength of materials

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	understand the various strain gauges and the principle of operation	TPS2	B	65
CO2	apply the principle to operation of the strain gauges into various practical problems	TPS3	B	65
CO3	apply the photo elasticity theory to stress analysis.	TPS3	B	65
CO4	apply geotechnical instrumentation	TPS3	B	65
CO5	understand various NDT technique and its principle of operation	TPS2	B	65
CO6	apply the various instrumentation involved in the measurement of structural parameters	TPS3	B	65

*** Weightage depends on Bloom's Level, number of contact hours,

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	4	24	-	-	-	-	-	-	-	-	-	-	2	12	-	-	-	-	-	20			-	-	-	-	-	-	-	-
CO2	4	-	32	-	-	-	-	-	-	-	-	-	2	-	16	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	4	-	32	-	-	-	-	-	-	-	-	-	2	-	16	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	4	-	32	-	-	-	2	-	16	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO5	-	-	-	-	-	-	4	24	-	-	-	-	2	12	-	-	-	-	-	-	-	-	-	-	-	20		-	-	-
CO6	-	-	-	-	-	-	4	-	32	-	-	-	2	-	16	-	-	-	-	-	-	-	-	-	-		40	-	-	-

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 - **Geo technical Instrumentations -** Dynamic soil properties **-**Cross hole test - Down hole test refraction test MASW test **NDT Methods -** Rebound hammer method - Ultra sonic pulse velocity technique- X-ray method, Gamma ray method - Corrosion measurements - linear polarization resistance - Open circuit potential measurements - Eddy current method **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

Learning Resources

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.	Topic	No. of Hours	Course Outcome
1	**Strain Gauges**		
1.1	Mechanical strain gauge	1	CO1
1.2	Optical strain gauge	1	CO1
1.3	Electrical resistance strain gauge	1	CO1
1.4	Inductance and capacitance strain gauges	1	CO1
1.5	Strain rosettes	1	CO2
1.6	Measurement of static and dynamic strain	2	CO2
1.7	Use of strain recorders and load cells ,calibration of testing machines	1	CO2
2	**Theory of Photo Elasticity**		
2.1	Birefringence, stress optic law, components of Polaris cope	1	CO3
2.2	Isochromatic and Isoclinic	1	CO3
2.3	Axial loading on tensile specimen, diametrically loaded disc	1	CO3
2.4	Four point bending, Plane Polariscope	2	CO3
2.5	Circular Polariscope	1	CO3
2.6	Stress freezing technique	1	CO3
3	**Geo technical Instrumentations**		

3.1	Dynamic soil properties	1	CO4
3.2	Cross hole test Down hole test	2	CO4
3.3	refraction test	1	CO4
3.4	MASW test	1	CO4
3.5	High strain test	1	CO4
4	**NDT Methods**		
4.1	Rebound hammer method	1	CO5
4.2	Ultra sonic pulse velocity technique	1	CO5
4.3	X-ray method,	1	CO5
4.4	Gamma ray method	1	CO5
4.5	Corrosion measurements - linear polarization resistance	2	CO5
4.6	Open circuit potential measurements	1	CO5
4.7	Eddy current method	1	CO5
5	**Instrumentation**		
5.1	LVDT (linear variable differential transducer) – transducers for velocity and acceleration measurement	2	CO6
5.2	Vibration meter	1	CO6
5.3	Seismographs	1	CO6
5.4	Cathode ray oscillograph	1	CO6
5.5	XY plotter, chart plotter	1	CO6
5.6	Digital acquisition systems	1	CO6
	Total Hours	**36**	

Course Designers:

1	Dr.R.Ponnudurai	rpdciv@tce.edu
2	R.Indrajith Krishnan	jith@tce.edu

22CERC0	COMPUTER AIDED DESIGN

Category	L	T	P	Credit
PEES	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

Design of Reinforced Concrete Elements (22CE610), and Design of Steel Elements

Course Outcomes

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

COs	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Formulate algorithm for solving equations and construct algorithm for truss problems using matrix method	TPS3	B	70
CO2	Construct algorithm for design of reinforced concrete members	TPS3	B	70
CO3	Construct algorithm for design of steel members	TPS3	B	70
CO4	Construct algorithm for analysis of prestressed concrete members	TPS3	B	70
CO5	Formulate spread sheet for design of structural elements and quantity estimation	TPS3	B	70
CO6	Develop stages of computer aided analysis and design including optimisation	TPS3	B	70

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern:

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
CO1	4	2	15	-	-	-	-	-	-	-	-	-	2	-	10	-	-	-	-	-	20		-	-	-	-	-	-	-	-
CO2	4	4	33	-	-	-	-	-	-	-	-	-	2	2	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	4	2	32	-	-	-	-	-	-	-	-	-	2	2	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	4	4	33	-	-	-	2	2	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO5	-	-	-	-	-	-	4	-	32	-	-	-	2	-	15	-	-	-	-	-	-	-	-	-	-		20	-	-	-
CO6	-	-	-	-	-	-	4	4	15	-	-	-	2	2	10	-	-	-	-	-	-	-	-	-	-		40	-	-	-

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 moment carrying capacity of steel beams. **Prestressed concrete:** Algorithm for analysis of prestressed rectangular and I sections in flexure – algorithm for finding losses in prestress. **Spread sheets:** Algorithm for developing spread sheet for various structural elements like beam-slab-column-footing and for quantity estimation. **Software Applications and Optimisation:** Introduction to optimisation – simple genetic algorithm; stages of computer aided analysis and design; Use of softwares to real time structural problems

Learning Resources

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 BC and Jain,A.K, "Comprehensive Design of Steel Structures", Laxmi Publications, 2006.

Course Contents and Lecture Schedule

S.NO	TOPICS	NO. OF PERIODS	COURSE OUTCOME
1	**Equation Solving and Matrix Method**		
1.1	Introduction	1	CO1
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	CO2
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	CO3
3.2	Algorithm for design of compression members	2	
3.3	Algorithm for finding load carrying capacity of light gauge steel columns	2	
4	**Prestressed Concrete**		
4.1	Introduction	1	CO4
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	2	
5	**Use of Spread Sheets**		
5.1	Algorithm for developing excel spread sheet – design of beams, slab, column and footing	2	CO5
5.2	Use of excel spread sheet –Quantity Estimation	2	
6	**Software Applications and Optimisation**		
6.1	Introduction to Optimisation- Simple genetic algorithm	1	CO6
6.2	Stages of Computer aided analysis and design	2	
6.3	Use of softwares – Real time structural problems	2	
	Total Hours	**36**	

Course Designers:

1. Dr. S. Nagan nagan_civil@tce.edu
2. Mr.R.Sankaranarayanan rsciv@tce.edu

22CERD0	ANTI-TERRORISM DESIGN ONSTRUCTURES

Category	L	T	P	Credit
PEES	3	0	**0**	**3**

Preamble

Disaster mitigation and its preparedness is the need of current scenarios. Blast induced loads on structures are results of accidents in the industries and also from evil minds. These disasters, if happened, may result devastating effect on infrastructure including operational facilities, buildings, bridges etc. This will not only cause monetary loss but importantly the loss of lives. The course is proposed with an aim of educating students for mitigation of blast effects on structures.

Prerequisite

NIL

Course Outcomes

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

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Explain the fundamentals of blast engineering and related blast dynamics.	TPS2	B	70
CO2	Understand the theoretical and practical aspects of the recent advancements made in blast resistant and anti-terrorism design of structures in existing facilities.	TPS2	B	70
CO3	Review the high strain rate behavior of material.	TPS3	B	70
CO4	Illustrate the characteristics of underground blast and its influence on geological factors.	TPS3	B	70
CO5	Plan and Design blast resistant strategies in structural and non-structural components using empirical approach and available commercial packages of finite element.	TPS3	B	70
CO6	Apply the Indian/international guidelines in design of blast resistant structure for intended level of threat scenario from chosen material.	TPS3	B	70

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
CO1	5	20	-	-	-	-	-	-	-	-	-	-	5	5	-	-	-	-	-	-	20		-	-	-	-	-	-	-	-
CO2	5	-	40	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	5	5	20	-	-	-	-	-	-	-	-	-	5	5	-	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	10	20	-	-	-	5	-	20	-	-	-	-	-	-	-	-	-	-		20	-	-	-
CO5	-	-	-	-	-	-	5	-	20	-	-	-	5	5	-	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO6	-	-	-	-	-	-	5	5	30	-	-	-	5	-	20	-	-	-	-	-	-	-	-	-	-		40	-	-	-

Syllabus

Blast Engineering: Nuclear Explosion, Blast phenomena, Characteristics of Explosives, Classification of Blast loading, TNT Equivalency, Buckingham Pi Theorem, Hopkinson's Scaling Law, Wave propagation, Interaction with structures, Fragments. **Load Regimes:** Impulse loading, Shock/Response spectra, Pressure-Impulse (PI) Diagrams; Analysis and concepts , Blast Load Calculations-Conventional Weapons Effects (ConWep) and Empirical Approaches, Jones-Wilkins-Lee (JWL),Equation of state (EOS) **Blast test and its responses:** Testing, Effects and behavior-SHPB and shock tube tests, High strain-rate response of materials, Assessing the Mechanics of Damage **Underground blast induced ground motion:** Characteristics of ground shock, Effect of geologic structure, blast induced liquefaction, loading on buried structure. **Design of Blast resistant structures:** Performance Based Blast design, Ductility, Support reaction, Mechanism of Progressive Collapse and Case studies, Controlled Demolition technique, Blast Analysis of Steel/Concrete members in Finite Element(FE) software and Hydro codes, Blast Resistant Design Concepts and member detailing- Steel, Concrete, masonry etc, Design of Steel/Concrete Buildings: Elastic and inelastic Behaviours, Ductility Requirements and Reinforcement detailing , Blast Resistant Design of Non Structural Components, Anti-Terrorism Planning and Design of Facilities, Blast Retrofitting. **Code of Practice:** Recommendations in Technical Manuals: Unified Facilities Criteria (UFC), TM-5-1300. Gaps in Indian Standard (IS) Code of Practice/International standards. **Case studies:** Case studies on man-made/natural explosion on structures.

Reference Books

1. Smith, P.D. and Hetherington, J.G. (1994). "Blast and Ballistic Loading of Structures",Oxford, Butterworth-Heinemann.
2. Mays, G.C. and Smith, P.D. (1995). "Blast Effects on Buildings", Thomas TelfordPublications, London, UK.
3. Meyers, M.A. (1994). "Dynamic Behavior of Materials", Wiley, NewYork (NY), USA.
4. Kinney, G.F. and Graham, K.J. (1985). "Explosive Shocks in Air",Springer, Berlin,Germany.
5. Dusenberry, D.O. (2010). "Handbook for Blast Resistant Design of Buildings", John Wiley and Sons, New Jersey (NJ), USA.
6. Krauthammer, T. (2008). "Modern Protective Structures", CRC Press,Boca Raton, Florida (FL), USA.
7. Bangash, M.Y.H. and Bangash, T. (2006). "Explosion-ResistantBuildings Design,Analysis and Case Studies", Springer, Berlin,Germany.
8. Henrych, J. (1979). "The Dynamics of Explosion and Its Use",Elsevier, Amsterdam, Netherlands.
9. Zukas, J.A. (2004). "Introduction to Hydrocodes", Oxford, Elsevier.
10. Goel, M.D. and Matsagar, V.A. (2014). "Blast Resistant Design of Structures",Practice Periodical on Structural Design and

Construction, American Society of CivilEngineers(ASCE), Vol. 19, No. 2, Article Number 04014007.

11. D.Rajkumar et al (2019). "A numerical study on parametric analysis of reinforced concrete column under blast loading" Journal of Performance of ConstructedFacilities (ASCE), DOI 10.1061/(ASCE)CF.1943-5509.0001382.
12. NPTEL notes-Introduction to Explosions and explosion safety.
13. Lecture notes on 'Five days short term course on "Blast Resistant and Anti-Terrorism Design of Structure using Advanced Materials" at VNIT,Nagpur from 26.08.2019 to 30.08.2019.

List of National and International Standards

1. IS 4991: 1968 Criteria for blast resistant design of structuresfor explosions above ground.
2. IS 6922: 1973 Criteria for safety and design of structures subjectto underground blasts.
3. Publications by: (1) the Department of Defense (DoD), UnifiedFacilities Criteria (UFC) Program, Washington, DC, USA; (2) theFederal Emergency Management Agency (FEMA), Washington, DC, USA; (3)the American Society of Civil Engineers (ASCE), Reston, Virginia (VA),USA.

List Of Software

LS-DYNA, ABAQUS

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1. Blast Engineering		
1.1	Nuclear Explosion, Blast phenomena	1
1.2	Characteristics of Explosives	1
1.3	Classification of Blast loading, TNT Equivalency	1
1.4	Buckingham Pi Theorem, Hopkinson's Scaling Law	1
1.5	Wave propagation, Interaction with structures, Fragments	1
2. Load Regimes		
2.1	Impulse loading, Shock/Response spectra	1
2.2	Pressure-Impulse (PI) Diagrams; Analysis and concepts	1
2.3	Blast Load Calculations-Conventional Weapons Effects (ConWep)	1
2.4	Blast Load Calculations-Empirical Approaches	1
2.5	Jones-Wilkins-Lee (JWL),Equation of state (EOS)	1
3. Blast test and its responses		
3.1	Testing, Effects and behavior-SHPB and shock tube tests	1
3.2	High strain-rate response of materials	1
3.3	Assessing the Mechanics of Damage	1
4. Underground blast induced ground motion:		
4.1	Characteristics of ground shock, Effect of geologic structure,	1
4.2	Blast induced liquefaction, loading on buried structure.	1

5. Design of Blast resistant structures		
5.1	Performance Based Blast design, Ductility, Support reaction	2
5.2	Mechanism of Progressive Collapse and Controlled Demolition technique with Case studies	2
5.3	Blast Analysis of Steel/Concrete members in Finite Element (FE) software and Hydro codes	3
5.4	Blast Resistant Design Concepts and member detailing; Steel, Concrete, masonry etc.	3
5.5	Design of Steel/Concrete Buildings: Elastic and inelastic Behaviours	2
5.6	Ductility Requirements and Reinforcement detailing	2
5.7	Blast Resistant Design of Non Structural Components	2
5.8	Anti-Terrorism Planning and Design of Facilities, Blast Retrofitting	2
6. Code of Practice		
6.1	Recommendations in Technical Manuals: Unified Facilities Criteria (UFC), TM-5-1300.	1
6.2	Gaps in Indian Standard (IS) Code of Practice/International standards	1
7. Case studies		
7.1	Case studies on man-made/natural explosion on structures	1
	Total periods	**36**

Course Designers:

1. Dr.D.Rajkumar, rajkumarcivil@tce.edu

22CERE0	DESIGN OF REINFORCED CONCRETE STRUCTURES

Category	L	T	P	Credit
PEES	3	0	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.

Prerequisite

22CE620 Design of Reinforced Concrete Elements

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Analyse and design the slabs based on Yield line theory and other flat and grid floor slab systems and detail the reinforcement	TPS3	B	70
CO2	Analyse and design the building frames by approximate methods and detail the reinforcement	TPS3	B	70
CO3	Design the foundation and detail the reinforcement	TPS3	B	70
CO4	Design the staircases and detail the reinforcement	TPS3	B	70
CO5	Design the retaining walls and detail the reinforcement	TPS3	B	70
CO6	Design the water tanks and detail the reinforcement	TPS3	B	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	4	4	20	-	-	-	-	-	-	-	-	-	2	2	10	-	-	-	-	-	20		-	-	-	-	-	-	-	-
CO2	4	2	30	-	-	-	-	-	-	-	-	-	2	-	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	4	2	30	-	-	-	-	-	-	-	-	-	2	2	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	4	-	20	-	-	-	2	-	10	-	-	-	-	-	-	-	-	-	-		20	-	-	-
CO5	-	-	-	-	-	-	4	4	30	-	-	-	2	2	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO6	-	-	-	-	-	-	4	4	30	-	-	-	2	2	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-

Syllabus

Slabs: Yield line theory - Equilibrium and virtual work method - Analysis and design of square, rectangular and circular slabs; Flat slab and grid floor system; Reinforcement detailing. **Building frames:** Approximate methods - Substitute frame method, Portal and Cantilever methods - Analysis and design of frame components; Reinforcement detailing. **Foundation**: Design principles of mat foundation, Design of piles and pile caps; Reinforcement detailing. **Staircases:** Single flight and dog-legged staircases, Stairs with stringer beams; Reinforcement detailing**. Retaining walls:** Reinforced concrete walls – Cantilever and counterfort retaining walls; Reinforcement detailing. **Water tanks**: Tank resting on ground, underground water tanks and elevated circular water tank; Reinforcement detailing.

Learning Resources

1. N. Krishna Raju Advanced Reinforced Concrete Design IS 456-2000, CBS Publishers and Distributors, New Delhi, Third Edition, 2020.
2. P.C. Varghese, Advanced Reinforced Concrete Design, Prentice Hall of India, Pvt. Ltd., New Delhi, 2013.
3. M.L. Gambhir, Design of Reinforced Concrete structures, Prentice Hall of India Private limited, New Delhi, 2012.
4. N. Subramanian, Design of Reinforced Concrete Structures, Oxford University Press, New Delhi, 2014.
5. B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, RCC Designs (Reinforced Concrete Structures), Laxmi Publications Pvt. Ltd., New Delhi, 2015.
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(1-2):1987 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures.
3. IS 875(3):2015 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures
4. IS 875(4-5):1987 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures
5. IS 2911(1): 2010 Design and construction of pile foundations – Code of practice – Concrete piles
6. IS 3370(Part 1-2): 2009 Code of Practice for Concrete Structures for the Storage of Liquids.
7. IS 3370 (Part 4): 1967 Code of Practice for Concrete Structures for the Storage of Liquids
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	Course Outcomes
1. Slabs			
1.1	Yield line theory - Analysis and design of square slab and	1	CO1

	its reinforcement detailing		
1.2	Yield line theory - Analysis and design of rectangular slab and its reinforcement detailing	2	CO1
1.3	Yield line theory - Analysis and design of circular slab and its reinforcement detailing	1	CO1
1.4	Design of flat slab and its reinforcement detailing	2	CO1
1.5	Design of grid floor system and its reinforcement detailing	2	CO1
2. Building Frames			
2.1	Analysis and design of a frame using substitute frame method and its reinforcement detailing	2	CO2
2.2	Analysis and design of a frame using Portal method and its reinforcement detailing	2	CO2
2.3	Analysis and design of a frame using cantilever method and its reinforcement detailing	2	CO2
3. Foundation			
3.1	Design principles of mat foundation and its reinforcement detailing	1	CO3
3.2	Design of pile and its reinforcement detailing	1	CO3
3.3	Design of pile cap and its reinforcement detailing	1	CO3
4. Staircases			
4.1	Design of single flight staircase and its reinforcement detailing	2	CO4
4.2	Design of dog-legged staircase and its reinforcement detailing	2	CO4
4.3	Design of stair with stringer beam and its reinforcement detailing	2	CO4
5. Retaining walls			
5.1	Design of cantilever retaining wall and its reinforcement detailing	2	CO5
5.2	Design of counterfort retaining wall and its reinforcement detailing	2	CO5
6. Water tanks			
6.1	Design principles of tank resting on ground	1	CO6
6.2	Design of tank resting on ground and its reinforcement detailing	2	CO6
6.3	Design principles of underground water tank	1	CO6
6.4	Design of underground water tank and its reinforcement detailing	2	CO6
6.5	Design principles of elevated water tank	1	CO6
6.5	Design of elevated water tank and its reinforcement detailing	2	CO6
	Total	**36**	

Course Designers:

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22CERF0	DESIGN OF STEEL STRUCTURES

Category	L	T	P	Credit
PEES	3	0	0	3

Preamble

This course offers the design of steel structures as per the limit state method. This course follows the recommendation of IS: 800 – 2007. It aims at determination of safe as well as economical steel components such as plate girders, gantry girders, and beam-columns. This course also expose the student to IS: 875 provisions for various load calculations. The design of roof truss using rolled and tubusectionstion using IS: 800-2007 is covered in this course. Framed connections such as beam to beam, beam to column connection are also dealt in this course.

Prerequisite

22CE320-Mechnics of Solids, 22CE520-Design of Steel Elements

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Design a Plate girder for its moment & shear and check the adequacy of the end panel using the IS800-2007 Provisions.	TPS3	A	70
CO2	Design of Longitudinal and transverse Stiffeners for the Plate girder.	TPS3	A	65
CO3	Analyze and design a gantry girder for its maximum load effects and fatigue effects.	TPS3	A	70
CO4	Evaluate the capacity of the column subjected to combined axial compression and bending moment.	TPS3	A	65
CO5	Calculate all the possible loads on the roof truss and its load combinations	TPS3	A	70
CO6	Design the purlins & roof truss members using rolled steel sections.	TPS3	A	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Assess ment	CAT1		CAT2		Terminal exam		Assignment 1	Assignment 2
TPS / COs	2	3	2	3	2	3	3	3
CO1	10	25	-	-	4	10	20	-
CO2	10	25	-	-	4	15	40	-
CO3	5	25	-	-	2	15	40	-
CO4	-	-	10	25	2	15	-	40
CO5	-	-	10	25	4	10	-	20
CO6	-	-	5	25	4	15	-	40

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 a 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 to vertical component of crane wheel load, the 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. **Industrial structures**: Pitched roof truss configuration such as Fink & Fink fan, Howe, Pratt, etc. Introduction to loads on truss using IS875 – Part-1 ,2 ,3, Possible Load combinations, Estimation of design dead load, live load, wind load on Roof and walls. Review of analysis of truss. **Design of Truss using Rolled steel sections**: Purlin design using rolled sections, design of truss member against tension and compression, design of Support.

Indian Standard Codes

1. IS: 800 – 2007, Code of Practice for general construction in steel, BIS, New Delhi
2. SP 6 (1) – Structural steel sections
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.
6. IS: 808 – 1989 Dimensions For Hot Rolled Steel Beam, Column, Channel and Angle Sections.

Learning Resources

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. Gaylord E H, Gaylord N C and Stallmeyer J E, "Design of Steel Structures", 3rd edition, McGraw Hill Publications, 1992.
4. Salmon, Johnson &Malhas," Steel Structures: Design and Behavior, 5th Edition, Pearson
5. Negi L.S. "Design of steel structures" McGraw Hill Co., New Delhi, 2014
6. Duggal S.K., "Limit state design of steel structures" McGraw Hill Co., New Delhi, 2014
7. www.nptel.ac.in
8. http://www.steel-insdag.org/TM_Contents.asp

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	Course Outcome
1.0	**Plate girder**		
1.1	Introduction to Plate girder – Difference between beam and plate girder & IS 800-2007.	1	CO1 & CO2
1.2	Design of welded plate girder	2	
1.2.1	Proportioning of web and flange plates – Design of mid-section		
1.3	Curtailment of flange plates	1	
1.4	shear behaviour of transversely unstiffened and stiffened web	2	
1.4.1	web subjected to co-existent bending and shear	2	
1.4.2	transverse web stiffener – Bearing stiffener	2	
1.4.3	End-bearing stiffener and load-bearing stiffener	1	

1.5	Longitudinal web stiffener	1	
1.5.1	Flange plate to web connection	1	
1.5.2	Splices - Flange and web	1	
2.0	**Gantry girder**		CO3
2.1	Introduction and load considerations	1	
2.2	Maximum load effects and Fatigue effects		
2.3	Determination of maximum bending moment and shear force due to vertical component of crane wheel load	1	
2.4	Determination of maximum bending moment and shear force due to horizontal component of crane wheel load and longitudinal effect of wheel load	1	
2.5	Design of gantry girder	1	
2.6	Connection in gantry girder	1	
3.0	**Beam-Column**		CO4
3.1	Introduction to the behavior of Beam-column and IS 800:2007	1	
3.2	Second-order moment in beam-column	2	
3.3	Elastic torsional buckling of beam-columns		
3.4	Nominal strength in beam-column in uniaxial bending	1	
3.5	Nominal strength in beam-column in biaxial bending	2	
4.0	**Industrial structures**:		CO5
4.1	Pitched roof truss configuration, Fink & Fink fan truss.	1	
4.2	Introduction to loads on truss using IS875 – Part-1 ,2 ,3, Possible Load combinations,	2	
4.3	Estimation of design dead load, live load, and wind load on Roof and walls. Review of analysis of truss.	2	
5.0	**Design of Truss using Rolled steel sections**		CO6
5.1	Purlin design using angle and channel sections,	2	
5.2	Design of members of Truss using Rolled steel sections	2	
5.3	Design of supports	2	
	Total Hrs.	36	

Course Designers:

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2. Ms.G.Celine Reena celinereena@tce.edu

Category	L	T	P	Credit
PEES	3	0	0	3

22CERG0	DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES

Preamble

This course deals with the Limit State Method of Design of Steel-Concrete Composite Structures. The discussion on the concept of Limit State Design based on the new IS: 11384 2022, has been included in this course. The design and detailing of a composite beam, column, slab etc. were dealt with in detail.

Prerequisite

22CE520-Design of Steel Elements, 22CE620 Design of Reinforced Concrete elements

Course Outcomes

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

CO	Course Outcomes	TCE Proficiency Scale	Expected Proficiency (Grade)	Expected Attainment level (%)
CO1	Understand the mechanism of composite action between steel and concrete and explain the types and behaviour of shear connectors.	TPS2	B	65
CO2	Construct the stress blocks of a composite beam at ultimate with or without profiled decking steel sheet for various neutral axis positions. Also, estimate the sectional properties of composite beams	TPS2	B	65
CO3	Design a composite beam with or without a profile decking steel sheet either simply supported or continuous end conditions using IS:11384-2022	TPS3	B	60
CO4	Design a composite slab with the provision of a profile decking steel sheet using IS:11384-2022	TPS3	B	65
CO5	Design Encased as well as In-filled composite columns using IS:11384-2022	TPS3	B	65
CO6	Design a Beam-column under uni-axial bending and bi-axial bending	TPS3	B	60

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Assessments	Assessment - I						Assessment - II						Terminal Exam		
	CAT1			Assignment-I*			CAT-II			Assignment-II*					
TPS / COs	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	5	5	20	-	-	20	-	-	-	-	-	-	2	5	
CO2	5	5	20	-	-	50	-	-	-	-	-	-	2	5	
CO3	5	5	30	-	-	30	-	-	-	-	-	-	2		20
CO4	-	-	-	-	-	-	-	5	30	-	-	30	2		20
CO5	-	-	-	-	-	-	-	10	20	-	-	50	2		20
CO6	-	-	-	-	-	-	-	5	30	-	-	20			20
Total	15	15	70			100		20	80			100	10	10	80

*Assignment I, II –Quiz/ Case analysis/ Problem-solving/ Presentation/ Writing tasks

Syllabus

Introduction to Steel-Concrete Composite Structures - Theory of Composite Structures – Modular ratio – Transformed section – Composite action – No interaction - Full interaction – Slip calculation -Types and load transferring mechanism of Shear connectors - Sectional property like moment of inertia -**IS:11384-2022Code provisions for steel concrete composites design –**Limit states for Strength and Limit States for Serviceability - Local buckling and section classification - Partial Safety Factors for loads and materials- Load combinations - Stress block – Ultimate moment capacity with or without profiled decking steel sheet. **Composite Beams** - Introduction to Composite beams - Ultimate moment behaviour – Types, merits and behaviour of profiled decking - Design consideration for simply supported and continuous composite beam with or without profiled steel sheeting – Problems - **Composite floors -** Introduction of composite floors – shear transferring mechanism in profile deck system - Bending resistance of composite slab - Design consideration of composite floor - Design of Composite floor- **Composite columns** - Introduction to composite columns and its applications - Resistance of encased composite column cross section and infilled composite column cross section under compression - Design consideration of both encased and infilled composite column under - axial compression, **Composite Beam-Column** – Interaction M-N Curve – Estimation of plastic moment capacity of beam-column - plastic capacity of encased and infilled composite column under uniaxial bending and biaxial bending – Problems.

Reference Books

1. Teaching resource for, "Structural Steel Design," Volume 2 of 3, Institute for Steel Development and Growth (INSDAG), 2002.
2. Johnson R.P (1994), "Composite Structures of Steel and Concrete", volume I, Black well scientific publication, U.K.1999.
3. Narayanan R, "Composite steel structures – Advances, design and construction", Elsevier, Applied science, UK, 1987
4. Handbooks of INSDAG (periodicals)
5. Website: www.steel-insdag.org

List of Standards

1. IS 11384-2022, Code of Practice for Composite Construction in Structural Steel and Concrete
2. IS 11384-1985, Code of Practice for Composite Construction in Structural Steel and Concrete
3. IS 875-1987, (Part-1,2 &3) Code of Practice for Design Load (other than Earthquake).
4. SP:6(1)-1964, Handbook for structural Engineers 1 – Structural Steel Sections
5. IS 456-2000 Code of Practice for general construction in RCC.
6. IS 800-2007 Code of Practice general construction in steel.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Hours	Course Outcomes
1.0	**Introduction to Steel-Concrete Composite Construction**	1	CO1
2.0	**Theory of Composite Structures**		
2.1	Concept of Modular ratio and Transformed section	1	CO1
2.2	Composite action - No interaction - Full interaction	1	CO1
2.3	Slip calculation, slip strain and slip diagram	1	CO1
2.4	Types and load transferring mechanism of Shear connectors	1	CO1
2.5	Load transferring mechanism of Shear connectors	1	CO1
2.6	Sectional properties like the moment of inertia and transformed area of cross-section.	1	CO1
3.0	**IS:11384-2022 provisions for steel concrete composites design**		
3.1	Provisions of IS: 11384, Code of Practice for composite construction in Structural Steel and Concrete	1	CO2
3.2	Limit states for Strength and Limit States for Serviceability	1	CO2
3.3	Provisions of IS 800: 2007, Code of Practice for General Construction in Steel and Provisions of IS 456: 2000	1	CO2
3.4	Local buckling and section classification, Partial Safety Factors	1	CO2
3.5	Design provisions for tension, compression, bending members and connections	1	CO2
3.6	Stress block – Ultimate moment capacity without profiled decking steel sheet	1	CO2
3.7	Stress block – Ultimate moment capacity with profiled decking steel sheet	1	CO2
4.0	**Composite Beams**		
4.1	Introduction to Composite beams - Ultimate moment behaviour	1	CO3
4.2	Types, merits and behaviour of profiled decking	1	CO3
4.3	Design consideration for simply supported continuous composite beam without profiled deck	1	CO3
4.4	Design consideration for simply supported continuous composite beam with profiled deck	1	CO3
4.5	Design consideration for a continuous composite beam without a profiled deck	1	CO3
4.6	Design consideration for a continuous composite beam with a profiled deck	1	CO3
5.0	**Composite floors**		
5.1	Introduction of composite floors	1	CO4
5.2	Discussion on shear transferring mechanism in the profile deck system	1	CO4
5.3	Bending resistance of the composite slab	1	CO4
5.4	Design consideration of composite floor	1	CO4
5.5	Shear consideration for vertical shear	1	CO4

5.6	Longitudinal shear resistance of a composite slab	1	CO4
6.0	**Composite columns**		
6.1	Introduction to composite columns and its applications	1	CO5
6.2	Design provision of the composite column under axial compression	1	CO5
6.3	Resistance of encased composite column cross-section under axial compression	1	CO5
6.4	Resistance of infilled composite column cross-section under axial compression	1	CO5
7.0	**Composite Beam-Column**		
7.1	Introduction to Beam-Column	1	CO6
7.2	Interaction M-N Curve	1	CO6
7.3	Discussion of resistance of beam-column at various salient points in the M-N curve	1	CO6
7.4	Estimation of moment resistance of the composite column	1	CO6
7.5	Resistance of uni-axial bending encased composite column	1	CO6
7.6	Resistance of bi-axial bending encased composite column	1	CO6
	Total	36	

Course Designers:

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Category	L	T	P	Credit
PEES	3	0	0	3

22CERH0	COLD FORMED STEEL STRUCTURAL DESIGN

Preamble

Cold-formed steel has been widely used in building construction, from residential houses to industrial buildings. This course discusses the manufacturing process of cold-formed steel, the fundamental theories of cold-formed steel design, the advantages of cold-formed steel over other construction materials, cold-formed steel applications in today's construction market, and the connection methods.

Prerequisite

22CE520-Design of Steel Elements

Course Outcomes

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

COS	Course Outcomes	TCE Proficiency Scale	Expected Proficiency (GRADE)	Expected Attainment level (%)
CO1	Understand the manufacturing process of cold-formed steel, the effect of cold work and other material properties	TPS2	B+	65
CO2	Demonstrate the local buckling, Post buckling of plate element under compression and behaviour of compression elements	TPS2	B+	65
CO3	Find out the adequacy of Cold-Formed steel flexural members that may be stiffened or unstiffened but with lateral support as per the provision of IS:801. Also, Check the adequacy of the CFS beam webs under web crippling as per IS:801.	TPS3	B+	65
CO4	Ascertain the adequacy of lateral buckling of CFS I beams and channels as per IS:801	TPS3	B+	60
CO5	Design the CFS member under axial compression	TPS3	B+	65
CO6	Find out the adequacy of CFS members subjected to bending and axial compression	TPS3	B+	60

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Assessments	Assessment - I						Assessment - II						Terminal Exam		
	CAT1			Assignment-I*			CAT-II			Assignment-II*					
TPS / COs	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	5	5	20	-	-	20	-	-	-	-	-	-	4	8	
CO2	5	5	20	-	-	30	-	-	-	-	-	-	2	8	
CO3	5	5	30	-	-	50	-	-	-	-	-	-	2		20
CO4	-	-	-	-	-	-	5	5	20	-	-	30	2		15
CO5	-	-	-	-	-	-	5	5	20	-	-	30	2		15
CO6	-	-	-	-	-	-	5	5	30	-	-	40	2		20
Total	15	15	70	-	-	100	15	15	70	-	-	100	14	16	70

*Assignment I, II –Quiz/ Case analysis/ Problem-solving/ Presentation/ Writing tasks

Syllabus

Introduction to Design of Cold-Formed Steel members–Typical sections and applications – Method of cold forming – Mechanical properties – Yield Stress, Tensile Strength, and Stress-Strain Curve - Modulus of Elasticity, Tangent Modulus, and Shear Modulus – Ductility - Influence of cold forming on mechanical properties –Bauchinger effects –**Behaviour and Design of thin elements** – local buckling of stiffened and unstiffened elements – Post buckling of plate elements under compression - Effective Width Formulae for imperfect elements in pure compression - Effective Width Formulae for imperfect elements under stress gradient – calculation of section properties of CFS members with or without intermediate stiffener – **CFS flexural member**[Laterally supported] – Beam with unstiffened compression flange –Beam with stiffened compression flange – flexural capacity of CFS flexural member with or without intermediate stiffeners – Deflection of CFS flexural members – CFS Beam webs – shear capacity - web crippling -**CFS lateral buckling of flexural member**–I beam and channels – Box and Hat sections – bracing requirements of beams – beam with wide flanges-shear lags – flange curlings – Z purlins – **CFS axially loaded compression member** – behaviour of CFS column under yielding and local buckling – Overall buckling of columns – Flexural buckling – Torsional and Torsional-Flexural buckling – Double Symmetric shapes – Single Symmetric shapes – **CFS Beam-Column** – Double symmetric shapes not subjected to Torsional or Torsional-Flexural buckling- Open section – subjected to Torsional -Flexural buckling **Direct Strength Method** – Introduction to AISI specification – simple flexural member and axial compression member – Introduction to CUFSM – solving simple problem in DSM using CUFSM (Covered in the Assignments and Tutorials).

Reference Books

1. Teaching resource for, “Structural Steel Design,” Volume 1, 2 of 3, Institute for Steel Development and Growth (INSDAG), 2002.
2. SP(6)-Part-5 -1980, Handbook for Structural Engineers, Cold-Formed, Light-Gauge Steel Structures, BIS, New Delhi.
3. Yu W W and LaBoube R A, Cold-Formed Steel Design, Wiley Publications, John Wiley & Sons (2018).
4. Gregory J. Hancock, Thomas M. Murray, Duane S.Ellifritt, Cold formed steel structures to the AISI specifications, Marcel Dekker, Inc, New York.
5. Dan Dubina, Viorel Ungureanu, Raffaele Landolfo, Design of Cold Formed Steel Structures, Eurocode-3-Part1-3, Published by ECCS – European Convention for Constructional Steelwork
6. Website: www.steel-insdag.org

List of Standards

1. IS 801 –2021 Code of Practice for Use of Cold-Formed Light Gauge Steel Structural Members in General Building Construction
2. IS 811 – 2019 Specification for Cold-formed light gauge structural Steel sections
3. IS 875-1987, (Part-1,2) Code of Practice for Design Load (other than Earthquake)
4. IS 875-2015, (Part-3) Code of Practice for Design Load (other than Earthquake)
5. IS 800-2007 Code of Practice general construction in steel
6. AISI S100-16 (R2020) w/S3-22, American Iron and Steel Institute Standard, North American Specification for the Design of Cold-Formed Steel Structural Members, AISI.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Hours	Course Outcomes
1.0	**Introduction to Design of Cold-Formed Steel Members**	1	CO1
1.1	Typical sections and applications	1	CO1
1.2	Method of cold forming	1	CO1
1.3	Mechanical properties – Yield Stress, Tensile Strength, and Stress-Strain Curve	1	CO1
1.4	Modulus of Elasticity, Tangent Modulus, Shear Modulus, Ductility	1	CO1
1.5	Influence of cold forming on mechanical properties – Bauchinger effects	1	CO1
2.0	**Behaviour and Design of thin elements**		CO2
2.1	Local buckling of stiffened and unstiffened elements	1	CO2
2.2	Post-buckling of plate elements under compression	1	CO2
2.3	Effective Width Formulae for imperfect elements in pure compression	1	CO2
2.4	Effective Width Formulae for imperfect elements under stress gradient	1	CO2
2.5	calculation of section properties of CFS members without intermediate stiffener	1	CO2
2.6	calculation of section properties of CFS members with intermediate stiffener	1	CO2
3.0	**CFS flexural member** [Laterally supported]		CO3
3.1	Beam with unstiffened compression flange	1	CO3
3.2	Beam with stiffened compression flange	1	CO3
3.3	The flexural capacity of CFS flexural members without intermediate stiffeners	1	CO3
3.4	The flexural capacity of CFS flexural members with intermediate stiffeners	1	CO3
3.5	Deflection of CFS flexural members	1	CO3
3.6	CFS Beam webs	1	CO3
3.7	shear capacity, web crippling	1	CO3
4.0	**CFS lateral buckling of the flexural member**		
4.1	CFS lateral buckling of a flexural member of I beams and channels	1	CO4
4.2	CFS lateral buckling of a flexural member Box and Hat sections	1	CO4
4.3	Bracing requirements of beams	1	CO4

4.4	Beam with wide flanges, shear lags – flange curling	1	CO4
4.5	The behaviour of Z purlins	1	CO4
4.6	Design of Z Purlins	1	CO4
5.0	**CFS axially loaded compression member**		
5.1	The behaviour of the CFS column under yielding and local buckling	1	CO5
5.2	Overall buckling of columns	1	CO5
5.3	Flexural buckling of Double Symmetric shapes	1	CO5
5.4	Torsional and Torsional-Flexural buckling of Single Symmetric shapes	1	CO5
6.0	**CFS Beam-Column**		
6.1	The behaviour of beam-column	1	CO6
6.2	Double symmetric shapes not subjected to Torsional or Torsional-Flexural buckling	1	CO5
6.3	Open section – subjected to Torsional -Flexural buckling	1	CO5
6.4	Design of CFS members subjected to flexural buckling	2	CO5
6.5	Design of CFS members subjected to Torsional or Torsional-Flexural buckling	2	CO5
	TOTAL	36	

Course Designers:

1. Dr.S.Arulmary samciv@tce.edu

CATEGORY	L	T	P	CREDIT
PEES	3	0	0	3

22CERJ0	RESOURCE AND ENERGY RECOVERY FROM WASTES

Preamble

This course work is focused on recovery of resources and energy from solid waste which includes sludge generated from wastewater. The process of material recovery and 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

NIL.

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency scale	Expected Proficiency	Expected Attainment Level %
CO1	Explain the various recovery processes and volume reduction processes on generated waste.	TPS2	A	65
CO2	Assess the biological process for transformation of solid waste to useful by-products	TPS3	A	65
CO3	Assess the Bio-chemical process for transformation of solid waste to useful by-products	TPS3	A	65
CO4	Assess the Thermo-chemical process for transformation of solid waste to useful by-products	TPS3	A	65
CO5	Analyse the recycling and recovery concepts of various solid wastes and E-waste	TPS3	A	65
CO6	Select appropriate technology to recover resources and energy from the waste generated by the community	TPS3	A	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

CO	CAT1			CAT2			Terminal			ASSIGNMENT I			ASSIGNMENT II		
TPS Scale	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	10	10	-	-	-	-	2	5	-		30				
CO2	5	10	25	-	-	-	2	5	10			30			
CO3	5	10	25	-	-	-	2	5	10			40			
CO4	-	-	-	5	10	15	2	5	10	-	-	-	-	-	30
CO5	-	-	-	5	10	15	2	5	15	-	-	-	-	-	30
CO6	-	-	-	5	10	25	-	5	15	-	-	-	-	-	40

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. **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, Potentials and constraints for composting in India-Largescale and decentralized plants, Vermiculture: definition, scope and importance – common species for culture, Environmental requirements - culture methods- Applications of vermiculture. **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:** Types and principles of energy conversion Processes, Incinerator - Mass Burn and RDF Systems- Composition and calorific value of fuels and waste, Emission Controls – flue gas cleaning, de-dusting, flue gas scrubbers, DeNOx processes, dioxins and furans, Alternative thermal processes: co-incineration, pyrolysis, Alternative thermal processes Gasification and Refuse Derived Fuel, Co-Processing technologies. **Recycling and recovery concepts:** Recycling technologies for paper, glass, metal, plastic, Used Lead Acid Battery Recycling –End of Life Vehicle Recycling, Electronic Waste Recycling , Waste Oil Recycling**–** Solvent Recovery, Case studies on Indian conditions and Best Practices. **Appropriate technologies**: Necessity of material recovery facility to achieve circularity, Recovery of metals from e-waste, Nitrogen and Phosphorus recovery from municipal wastewater and sludge, Waste plastic management and conversion into liquid fuel and carbon materials, Resource recovery from solid waste- Case studies on Indian conditions and Best Practices.

Learning Resources

1. AarneVeslind 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 AA (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 Hours	Course Outcome
1.0	**Mechanical processing for material recycling**		
1.1	Resource recovery for a sustainable development	1	CO1
1.2	Material and energy flow management and analysis	1	CO1
1.3	Systems and processes for reduction, reuse and recycling	1	CO1
1.4	Objectives of Waste Processing-Source Segregation and Hand Sorting	1	CO1
1.5	Waste Storage and Conveyance – Shredding – Pulping	1	CO1
1.6	Size Separation by Screens- Density Separation by Air Classification –magnetic and electromechanical separation processes	1	CO1
2.0	**Biological processing for resource recovery**		
2.1	Mechanisms of Biological Processing – Aerobic Processing of Organic fraction	1	CO2
2.2	Composting Methods and processes- factors affecting	1	CO2
2.3	Design of Windrow Composting Systems- In Vessel Composting- Compost Quality Control	1	CO2
2.4	Potentials and constraints for composting in India-Largescale and decentralized plants.	1	CO2
2.5	Vermiculture: definition, scope and importance – common species for culture	1	CO2
2.6	Environmental requirements - culture methods-Applications of vermiculture	1	CO2
3.0	**Bio-chemical conversion of waste to energy**		
3.1	Principles and Design of Anaerobic Digesters – Process characterization and control	1	CO3
3.2	The biochemistry and microbiology of anaerobic treatment - Toxic substances in anaerobic treatment	1	CO3
3.3	Methane generation by Anaerobic Digestion	1	CO3
3.4	Anaerobic reactor technologies – Commercial anaerobic Technologies	1	CO3
3.5	Single stage and multistage digesters- Digester design and performance	1	CO3
3.6	Gas collection systems-Methane Generation and Recovery in Landfills – Biofuels from Biomass	1	CO3
4.0	**Thermo-chemical conversion of waste to energy**		
4.1	Types and principles of energy conversion Processes	1	CO4
4.2	Incinerator - Mass Burn and RDF Systems-Composition and calorific value of fuels and waste,	1	CO4
4.3	Emission Controls – flue gas cleaning, de-dusting, flue gas scrubbers, DeNOx processes, dioxins and furans	1	CO4
4.4	Alternative thermal processes: co-incineration, pyrolysis,	1	CO4
4.5	Alternative thermal processes Gasification and Refuse Derived Fuel	1	CO4
4.6	Co-Processing technologies	1	CO4
5.0	**Recycling and recovery concepts**		
5.1	Recycling technologies for paper, glass, metal, plastic	1	CO5
5.2	Used Lead Acid Battery Recycling –End of Life Vehicle Recycling	1	CO5
5.3	Electronic Waste Recycling	1	CO5

5.4	Waste Oil Recycling – Solvent Recovery	1	CO5
5.5	Case studies on Indian conditions and Best Practices	2	CO5
6.0	**Appropriate technologies**		
6.1	Necessity of material recovery facility to achieve circularity	1	CO6
6.2	Recovery of metals **from e-waste**	1	CO6
6.3	Nitrogen and Phosphorus recovery from municipal wastewater and sludge	1	CO6
6.4	Waste plastic management and conversion into liquid fuel and carbon materials	1	CO6
6.5	Resource recovery from solid waste- Case studies on Indian conditions and Best Practices	2	CO6
	TOTAL	**36**	

Course Designers:

1. Dr. R.K.C. Jeykumar rkcjciv@tce.edu
2. Dr. V. Ravisankar environmentengr@tce.edu

22CERK0	INDUSTRIAL WASTE WATER MANAGEMENT

Category	L	T	P	Credit
PEES	3	0	0	3

Preamble

As a fast 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, physico-chemical treatment and biological treatment.

Course Outcomes

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

COs	Course Outcome	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Fix the characteristics of the wastewater generated from any industry and identify factors influencing their generation	TPS2	A	65
CO2	Identify the means and methods to reduce the quantity of generation of wastewater by implementing Pollution Prevention programme	TPS3	A	65
CO3	Develop appropriate treatment systems for the wastewater generated from the industries	TPS3	A	65
CO4	Identify the possible recycling and reuse opportunities for the generated wastewater and residuals by employing suitable treatment units	TPS3	A	65
CO5	Investigate the feasibility and benefits of individual, common and joint treatment of industrial wastewater	TPS3	A	65
CO6	Suggest suitable treatment schemes for wastewater generated from specific industries based on their characteristics	TPS3	A	65

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	10	10	-	-	-	-	-	-	-	-	-	-	5	5	-	-	-	-	-	20	-		-	-	-	-	-	-	-	-
CO2	10	10	20	-	-	-	-	-	-	-	-	-	5	5	10	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	10	10	20	-	-	-	-	-	-	-	-	-	5	5	10	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	10	10	20	-	-	-	5	5	10	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-
CO5	-	-	-	-	-	-	-	10	20	-	-	-	-	5	10	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-
CO6	-	-	-	-	-	-	-	10	20	-	-	-	-	5	10	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-

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.

Text Book:

1. S.C.Bhatia, Handbook of Industrial Pollution and Control, Volume I and II, CBSPublishers, New Delhi, 2003.
2. Mahajan, S.P.Pollution Control in Process Industries, Tata McGraw Hill Publishing Co.,New Delhi, 1991.

Reference Books

1. Arceivala, S.J., “Wastewater Treatment for Pollution Control”, Tata McGraw Hill, 2006.
2. Eckenfelder, W.W., “Industrial Water Pollution Control”, McGraw – Hill, 2005.
3. Shirish H. Sonawane., “Innovative Technologies for the Treatment of Industrial Wastewater: A Sustainable Approach”, Apple Academic Press, 2017.
4. Ranade, Vivek V., and Vinay M. Bhandari. Industrial wastewater treatment, recycling and reuse. Butterworth-Heinemann, 2014.
5. Frank Woodard, Industrial Waste Treatment Handbook, Butterworth Heinemann, New Delhi, 2010.
6. Paul L. Bishop “Pollution Prevention: - Fundamentals and Practice”, McGraw – Hill International, 2009.
7. 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	Course Outcome
1.0	**Introduction to industrial wastewater**		
1.1	Industrial scenario in India–industrial activity and environment - Uses of water by industry	1	CO1
1.2	Sources and types of industrial wastewater	1	CO1
1.3	Regulatory requirements for treatment of industrial wastewater	1	CO1
1.4	Wastewater generation rates	1	CO1
1.5	Characterization and variables, population equivalent	2	CO1
2.0	**Industrial Pollution Prevention**		
2.1	Prevention Vs Control of industrial pollution	1	CO2
2.2	Benefits and barriers	1	CO2
2.3	Source reduction techniques	1	CO2
2.4	Waste audit	1	CO2
2.5	Evaluation of pollution prevention option	1	CO2
2.5.1	Environmental statement	1	CO2
2.5.2	Waste minimization circles–PCB Norms for water usage in industries	1	CO2
3.0	**Industrial Wastewater Treatment**		
3.1	Recall of Conventional treatment system	1	CO3
3.2	Advanced chemical oxidation - Electro- chemical oxidation	1	CO3
3.2.1	Wet air oxidation - Ozonation -Photocatalysis	1	CO3
3.3	Heavy metal removal	1	CO3
3.4	Refractory organics separation by adsorption	1	CO3
3.5	Ion exchange	1	CO3
3.6	Membrane technologies	2	CO3
3.7	Nutrient removal	1	CO3
4.0	**Wastewater Reuse and Residual Management**		
4.1	Evaporation-Types of evaporators and classification	1	CO4
4.2	Zero effluent discharge systems	1	CO4
4.3	Quality requirement for reuse and disposal	1	CO4
4.4	Quantification and characteristics of sludge	1	CO4
4.4.1	Thickening, digestion, conditioning, dewatering and disposal of sludge.	2	CO4
4.5	Management of RO reject	1	CO5
4.6	Individual, common and joint treatment	2	CO5
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 distilleries.	5	CO6
TOTAL		**36**	

Course Designer(s):

1 . Dr. T.VelRajan tvciv@tce.edu
2. Ms. J.Eunice jeeciv@tce.edu

CATEGORY	L	T	P	CREDIT
PEES	3	0	0	3

22CERL0	**SUSTAINABLE MANAGEMENT OF URBAN ECOLOGY**

Preamble

This course provides an overview of various theoretical perspectives, debates and research practices in urban ecology, urban ecosystems, and urban sustainability. This course work covers the concept of sustainable management especially in the urban environment. The future of urban ecosystems and managing the climate change through the concept of future proofing is also addressed.

Prerequisite

Ecology &Environmental Science and Wastewater Engineering

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency scale	Expected Proficiency	Expected Attainment Level %
CO1	Explain the concept of sustainable development in urban perspective.	TPS2	A	65
CO2	Describe the concept of urban ecology and its framework	TPS2	A	65
CO3	Link the relationships between Smart cities and urban ecology	TPS3	A	65
CO4	identify the issues and challenges of Sustainable Water Management In Urban Areas	TPS3	A	65
CO5	Connect sustainability concepts and technology to real-world urban challenges in wastewater management	TPS3	A	65
CO6	Develop the future urban ecosystems keeping the climate change as a constraint.	TPS3	A	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

CO	CAT1			CAT2			Terminal			ASSIGNMENT I			ASSIGNMENT II		
TPS Scale	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	10	20	-	-	-	-	2	10	-	-	30	-			
CO2	10	20	-	-	-	-	2	10	-			30			
CO3	5	10	25	-	-	-	2	5	10			40			-
CO4	-	-	-	5	10	15	2	5	10	-	-	-	-	-	30
CO5	-	-	-	5	10	15	2	5	15	-	-	-	-	-	30
CO6	-	-	-	5	10	25	-	5	15	-	-	-	-	-	40

Syllabus

Introduction to Sustainable Development: Definitions and principles of Sustainable Development-History and emergence of the concept of Sustainable Development, Environment and Development linkages –Globalization and environment- Millennium Development Goals: Status (global and Indian),Environmental Sustainability Planning-Measuring Sustainability, Components of urban ecosystem, structure and function of ecosystem, Urbanization, population density and impact on ecosystem, Carrying Capacity And its Limits. **Introduction to urban ecology:** Processes in human population growth, urbanization and implications for urban ecology, Features of urban sustainability, Social dimensions, Economic dimensions, Ecological dimensions, Urban Ecosystem Challenges and opportunities of urban, rural and Periurban growth, Concept of Ecological Foot print, Urban Ecological Framework-, principles. **Urban ecology and sustainable urbanism:** Concepts and theories of urban ecology and linkages with sustainable urbanism, Concepts of Eco cities, smart cities, compact cities etc, Smart Cities": Critique and Contestations, Urban areas and ecological ecosystem services, Planned Cities" and Renewal Missions, Environmental perspectives on Urban master plans. **Urban water resources management:** Water in urban ecosystem- Urban Water Cycle, Urban water resources planning and organization aspects, Rainfall- runoff- Groundwater Recharge in urban regions, Storm water management practices storage capacity of urban components Water harvesting Structures, Integrated Water Resources Management-Water pricing, Case studies -Conflicts on Interstate water disputes. **Urban wastewater management:** Status of Wastewater treatment and disposal on India/ developed nations, Status of water pollution, Eco friendly treatment systems-concept of decentralization, Bio remediation, Phytoremediation, Wastewater management policy and models of Developed nations-Case studies, Case study on restoration of rivers. **Future of Urban Ecosystems:** Scenario Planning and Adaptive Management, NAPCC, Urban ecosystems-terrace garden, vertical garden etc, 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, Case studies on Indian conditions and Best Practices.

Learning Resources

1. Neil S. Grigg., "Urban Water Infrastructure Planning – Management and Operations", John Wiley and Sons, 1986.
2. Philip James, JariNiemelajurgenH .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.	Topic	No. of Hours	Course Outcome
1.0	**Introduction to Sustainable Development**		
1.1	Definitions and principles of Sustainable Development - History and emergence of the concept of Sustainable Development	1	CO1
1.2	Environment and Development linkages - Globalization and environment- Millennium Development Goals: Status (global and Indian)	1	CO1
1.3	Environmental Sustainability Planning- Measuring Sustainability	1	CO1
1.4	Components of urban ecosystem, structure and function of ecosystem,	1	CO1
1.5	Urbanization, population density and impact on ecosystem	1	CO1
1.6	Carrying Capacity And its Limits	1	CO1
2.0	**Introduction to urban ecology**		
2.1	Processes in human population growth, urbanization and implications for urban ecology	1	CO2
2.2	Features of urban sustainability	1	CO2
2.3	Social dimensions, Economic dimensions, Ecological dimensions	1	CO2
2.4	Urban Ecosystem Challenges and opportunities of urban, rural and Periurban growth,	1	CO2
2.5	Concept of Ecological Foot print.	1	CO2
2.6	Urban Ecological Framework-, principles	1	CO2
3.0	**Urban ecology and sustainable urbanism**		
3.1	Concepts and theories of urban ecology and linkages with sustainable urbanism	1	CO3
3.2	Concepts of Eco cities, smart cities, compact cities etc.	1	CO3
3.3	Smart Cities": Critique and Contestations	1	CO3
3.4	Urban areas and ecological ecosystem services	1	CO3
3.5	Planned Cities" and Renewal Missions	1	CO3
3.6	Environmental perspectives on Urban master plans	1	CO3
4.0	**Urban water resources management**		
4.1	Water in urban ecosystem- Urban Water Cycle	1	CO4
4.2	Urban water resources planning and organization aspects	1	CO4
4.3	Rainfall- runoff- Groundwater Recharge in urban regions	1	CO4
4.4	Storm water management practices storage capacity of urban components Water harvesting Structures	1	CO4
4.5	Integrated Water Resources Management-Water pricing	1	CO4
4.6	Case studies -Conflicts on Interstate water disputes	1	CO4
5.0	**Urban wastewater management**		
5.1	Status of Wastewater treatment and disposal on India/	1	CO5

	developed nations		
5.2	Status of water pollution	1	CO5
5.3	Eco friendly treatment systems-concept of decentralization	1	CO5
5.4	Bio remediation, Phytoremediation	1	CO5
5.5	Wastewater management policy and models of Developed nations-Case studies	1	CO5
5.6	Case study on restoration of rivers	1	CO5
6.0	**Future of Urban Ecosystems**		
6.1	Scenario Planning and Adaptive Management, NAPCC	1	CO6
6.2	Urban ecosystems-terrace garden, vertical garden etc	1	CO6
6.3	Ecological Design, Emerging Trends and Technologies	1	CO6
6.4	Integrated Models, Climate modifications and managing climate change challenges in cities,	1	CO6
6.5	Adaptation and mitigation measures to make cities resilient& Future proofing of cities	1	CO6
6.6	Case studies on Indian conditions and Best Practices	1	CO6
	Total	36	

Course Designers:

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2. Dr. V. RaviSankar environmentengr@tce.edu

22CERM0	ENVIRONMENTAL POLICIES AND LEGISLATIONS

CATEGORY	L	T	P	CREDIT
PEES	3	0	0	3

Preamble

This course work provides an in-depth understanding of the vast field of Environmental law and policy and the study would be familiar with the overall legal regime of the country as well as international obligations. To impart knowledge on the policies, legislations, institutional framework and enforcement mechanism for environmental management in India.

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency scale	Expected Proficiency	Expected Attainment level (%)
CO1	Explain the Indian Legal System and the fundamentals of Indian Constitution.	TPS2	A	70
CO2	Discuss the legal regime established under the Constitution in India on environment and its protection.	TPS3	A	70
CO3	Apply the provision for legal control of industrial pollution by legislations	TPS3	A	70
CO4	Critically analyze environmental laws within various contexts and to evaluate laws against procedural and substantive criteria.	TPS3	A	70
CO5	Discuss the origin, evolution and expansion of international environmental law.	TPS3	A	70
CO6	Illustrate the Concepts evolved through judicial decisions with suitable case laws in Indian Courts.	TPS3	A	70

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

CO	CAT1			CAT2			Terminal			ASSIGNMENT I			ASSIGNMENT II		
TPS Scale	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	5	15	-	-	-	-	2	5	-	-	30	-	-	-	-
CO2	5	10	25	-	-	-	2	5	10	-	-	30	-	-	-
CO3	5	10	25	-	-	-	2	5	10	-	-	40	-	-	-
CO4	-	-	-	5	10	15	2	5	10	-	-	-	-	-	30
CO5	-	-	-	5	10	15	2	5	15	-	-	-	-	-	30
CO6	-	-	-	5	10	25	-	5	15	-	-	-	-	-	40

Syllabus

Fundamentals of Law and Legal system: Introduction to law- Indian legal system, Fundamentals of Indian constitution, Statutes, Rules and Notification, Fundamental rights- Writ petitions, Public Interest Litigations-RTI Act, Significance of Environmental Law and International Environmental Law. **Indian Constitution and Environmental Protection:** Indian Constitution and Environmental Protection, Constitutional provisions concerning Environment Articles14,15, (2) (b)19(e),21,31,32,38,39,42,47,48-A,49,51,51-A, Common Law & Criminal Law –Nuisance & Negligence, Concepts of Liabilities -Strict liability and Absolute liability, Right To Environment – A Basic Human Right: A Constitutional Law Perspective, National Environmental Policy 2006.**Remedies for Environmental Pollution:** Provisions of IPC relating to environmental problems (public nuisance u/s 268 and others (Sections 269,270,277,284,285,286,425 to 440), Common Law Remedies/Remedies under Law of Tort-Section133ofCr.P.C, Penal Remedies– Indian Penal Code and Code of Criminal Procedure, Remedies under Constitutional Law – Writs, Public Liability Insurance Act, 1991, The National Green Tribunal Act 2010.**Major Indian legislations:** Water Act (1974)- Power & Functions of Regulatory, Air Act (1981)- Power & Functions- Noise Pollution rules, Environmental Protection Act (1986) Genesis of the act–Delegation of Powers, Waste Management Laws, Environment Impact Assessment and Coastal Regulation Zone Notifications, Natural Resources protection legislations. **Environmental legislations international scenario:** Development of International Environmental Law-General Issues of the international law related to environmental protection, Stockholm Declaration**-**Rio Declaration on Environment and Development, Montreal Protocol on Substances that deplete Ozone Layer, Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their disposal, Convention of Biological Diversity, U.N Frame Work Convention on Climate Change-Kyoto Protocol. **Environment and Development case laws:** Meaning and concept of development - Its impact on environment; conflict between environment development, Concept of Sustainable Development., Polluter Pay Principle, Precautionary Principle, Public Trust Doctrine, Landmark Judgments**-**Olium gas leakage case, Rural Litigation and Entitlement Kendra, Dehradun,(1985), Vellore Citizen Welfare Forum v. Union of India,(1996)5SCC647), S. Jagannath v. UOI (1997) SCC867 Ganga Pollution case(1988), Vellore Citizens welfare forum case M.C.Mehta Vs. Kamalnath (1997) I SCC388.

Learning Resources

1. CPCB,-Pollution Control acts, Rules and Notifications issued there under‖ Pollution Control Series, Central Pollution Control Board, Delhi.
2. GregerI. Megregor,-Environmental law and enforcement ‖,Lewis Publishers, London, 1994.
3. Shyam Divyan and Armin Roseneranz-Environmental law and policy in India‖ Oxford University Press,NewDelhi,2001.
4. TNPCBandYOU-AReadyReckonerforEntrepreneurs‖–TamilNaduPollutionControl Board2013

Course Contents and Lecture Schedule

Module No.	TOPIC	No. of Lectures	COURSE OUTCOME
1.0 Fundamentals of Law and Legal system			
1.1	Introduction to law- Indian legal system	1	CO1
1.2	Fundamentals of Indian constitution	1	CO1
1.3	Statutes, Rules and Notification	1	CO1
1.4	Fundamental rights- Writ petitions	1	CO1
1.5	Public Interest Litigations-RTI Act	1	CO1
1.6	Significance of Environmental Law and International Environmental Law.	1	CO1
2.0 Indian Constitution and Environmental Protection			
2.1	Indian Constitution and Environmental Protection	1	CO2
2.2	ConstitutionalprovisionsconcerningEnvironmentArticles14,15,(2)(b)19(e),21,31,32,38,39,42,47,48-A,49,51,51-A	1	CO2
2.3	Common Law & Criminal Law –Nuisance &	1	CO2
2.4	Concepts of Liabilities -Strict liability and Absolute liability,	1	CO2
2.5	Right To Environment – A Basic Human Right: A Constitutional Law Perspective	1	CO2
2.6	National Environmental Policy 2006	1	CO2
3.0 Remedies for Environmental Pollution			
3.1	Provisions of IPC relating to environmental problems (public nuisance u/s 268 and others (Sections 269,270,277,284,285,286,425 to 440)	1	CO3
3.2	Common Law Remedies/Remedies under Law of Tort-Section133ofCr.P.C	1	CO3
3.3	Penal Remedies–Indian Penal Code and Code of Criminal Procedure	1	CO3
3.4	Remedies under Constitutional Law – Writs	1	CO3
3.5	Public Liability Insurance Act, 1991	1	CO3
3.6	The National Green Tribunal Act 2010	1	CO3
4.0 Major Indian legislations			
4.1	Water Act (1974)- Power & Functions of Regulatory	1	CO4
4.2	Air Act (1981)- Power & Functions- Noise Pollution	1	CO4
4.3	Environmental Protection Act (1986) Genesis of the act–Delegation of Powers	1	CO4
4.4	Waste Management Laws	1	CO4
4.5	Environment Impact Assessment and Coastal Regulation Zone Notifications	1	CO4
4.6	Natural Resources protection legislations	1	CO4
5.0 Environmental legislations international scenario			
5.1	Development of International Environmental Law- General Issues of the international law related to environmental protection	1	CO5
5.2	Stockholm Declaration-Rio Declaration on Environment and Development-	1	CO5

5.3	Montreal Protocol on Substances that deplete Ozone Layer	1	CO5
5.4	Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their disposal	1	CO5
5.5	Convention of Biological Diversity	1	CO5
5.6	U.N Frame Work Convention on Climate Change-Kyoto Protocol	1	CO5
	6.0 Environment and Development case laws		
6.1	Meaning and concept of development - Its impact on environment; conflict between environment development	1	CO6
6.2	Concept of Sustainable Development., Polluter Pay Principle, Precautionary Principle, Public Trust Doctrine	1	CO6
6.3	Landmark Judgments**-** Olium gas leakage case, Rural Litigation and Entitlement Kendra, Dehradun,(1985)	1	CO6
6.4	Vellore Citizen Welfare Forum v. Union of India,(1996)5SCC647)	1	CO6
6.5	S. Jagannath v. UOI (1997) SCC867 Ganga Pollution case(1988)	1	CO6
6.6	Vellore Citizens welfare forum case M.C.Mehta Vs. Kamalnath (1997) I SCC388	1	CO6
	Total Periods	**36**	

Course Designers:

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22CERN0	ENVIRONMENTAL REMOTE SENSING

CATEGORY	L	T	P	CREDIT
PEES	3	0	0	3

Preamble

Remote sensing techniques are very much useful for environmental data acquisition and analysis. Geographical Information System is another important scientific tool in making decisions in environmental management issues based on the input data. This course work deals with the principles and techniques and the data processing in remote sensing, concepts of GIS, database management, GIS softwares and the applications of RS and GIS.

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency scale	Expected Proficiency	Expected Attainment Level %
CO1	Understand the fundamental principles of EMR.	TPS2	A	85
CO2	Understand remote sensing data transmission and collection systems.	TPS2	A	85
CO3	Apply basic image analysis techniques for environmental issues.	TPS3	B	75
CO4	Analysis of GIS data through the concepts of GIS data input and management.	TPS3	B	75
CO5	Application of Remote Sensing and GIS techniques to real-world environmental issues	TPS3	C	65
CO6	Interpret and extract pertinent information from survey of literature	TPS3	C	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern :

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	20	-	-	-	-	-	-	-	-	-	-	2	10	10	-	-	-	-	-	25		-	-	-	-	-	-	-	-
CO2	5	20	-	-	-	-	-	-	-	-	-	-	2	10	10	-	-	-	-	-	25		-	-	-	-	-	-	-	-
CO3	-	20	30	-	-	-	-	-	-	-	-	-	2	-	10	-	-	-	-	-	50		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	10	20	-	-	-	2	-	10	-	-	-	-	-	-	-	-	-	-		50	-	-	-
CO5	-	-	-	-	-	-	5	10	20	-	-	-	2	-	15	-	-	-	-	-	-	-	-	-	-		25	-	-	-
CO6	-	-	-	-	-	-	-	10	20	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-		25	-	-	-

Syllabus

Principles of Remote Sensing: The electromagnetic spectrum - Atmospheric effects-Energy interaction and spectral responses of earth surface features. **Remote Sensors and Systems:** Sensors - Resolution types **-** Multispectral remote sensing systems - Thermal infrared remote sensing **Digital Image Processing and Analysis**: Image data format and types. Image interpretation techniques - Image pre-processing and rectification- Image enhancement - Image classification – Spatial filtering- Band combination. **Geographical Information System:** GIS concepts**-** Spatial and non spatial data, Vector and raster data structures**-** Data analysis**. Remote Sensing and GIS applications:** Monitoring changes in global vegetation cover-. Surface and ground water resources - Remote sensing of urban environments - Monitoring Earth's atmosphere**, Survey of Literature** - Literature Survey of RS-GIS.

Course content and lecture schedule

S. No	Topic	No. of Lectures	CO
	1. Principles of Remote Sensing		
1.1	The electromagnetic spectrum – source, properties, radiation laws.	1	CO1
1.2	Atmospheric effects –scattering, absorption and reflection. Atmospheric windows–spectral reflectance- spectral signatures.	1	CO1
1.3	Energy interaction and spectral responses of earth surface features – land, water, vegetation and soils.	1	CO1
	2. Remote Sensors and Systems		
2.1	Sensors- types and its resolutions	1	CO2
2.2	Thermal infrared sensors, Radar and microwave radiometers.	1	CO2
2.3	Multispectral Remote Sensing systems – data collection, multi spectral imaging using detectors, scanning mirrors, line arrays, scanners.	2	CO2
2.4	Thermal Remote sensing - properties, laws, data collection and examples.	1	CO2
	3. Digital Image Processing and Analysis		
3.1	Image data format, types of data and its significance.	1	CO3
3.2	Image pre-processing– radiometric corrections- line drop, de stripping, scattering correction, geometric distortions and earth rotation and correction.	2	CO3
3.3	Image rectification -– Generation of images to map by various important models.	2	CO3
3.4	Image enhancement and interpretation – linear contrast stretch, histogram equalization, logarithmic and exponential contrast enhancement.	2	CO4
3.5	Image classification - Image CO selection - supervised and Unsupervised techniques.	2	CO4
3.6	Spatial filtering – noise removal, edge enhancement, edge extraction and normalization.	2	CO4
3.7	Band combination – linear, ratioing, Principal component analysis.	2	CO4
	4. Geographical Information System		
4.1	GIS concepts, map projection and coordinate system.	1	CO5
4.2	Spatial and non-spatial data, Vector and raster data structures	1	CO5
4.3	Vector data analysis – buffering and overlaying	2	CO5
4.4	Rasterd at a analysis – local, neighborhood, zonal operations and distance measure operations.	2	CO5

5. Remote Sensing and GIS applications			
5.1	**Monitoring changes in global vegetation cover:** EM spectrum of vegetation. Vegetation indices. Biophysical properties and processes of vegetation. Classification systems. Global vegetation and land cover mapping programmers.	2	CO6
5.2	**Surface and ground water resources:** Remote sensing of inland water quality and sediment load. Mapping watersheds and groundwater recharge and discharges it eat the regional scale.	2	CO6
5.3	**Remote sensing of urban environments:** Urbanization, land use and land cover, critical environmental assessment and disaster emergency response.	2	CO6
5.4	**Monitoring Earth's atmosphere:** The status of Earth's atmosphere – ozone, carbondioxide and atmospheric dust.	1	CO6
6.0	Literature Survey of RS-GIS	2	CO6
Total Periods		36	

Reference Books

1. Burrough,P.A.andMcDonnell,R.A.,PrinciplesofGeographicInformationSystems, OxfordUniversityPress,NewYork,2001.
2. JohnR Jensen, ‐ Remote Sensing of the Environment: An Earth Resource Perspective(2ndEdition,2006) Pearson Publication.
3. Samuel Purkis and Victor Klemas, ― Remote Sensing and Global Environmental Changeǁ (2011), Wiley - Blackwell, AJohnWiley &Sons,Ltd. Publication.
4. ThomasLilles and, RalphW.Kiefer, Jonathan Chipman, ‐ Remote Sensing and Image Interpretation, 6thEdition(2008) JohnWiley & Sons, Publications.

Course Designer

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22CERP0	SURFACE AND GROUND WATER QUALITY MODELLING

CATEGORY	L	T	P	CREDIT
PEES	3	0	0	3

Preamble

Modeling is a very useful tool in studying and forecasting the environmental quality parameters. The mathematical models would be of great support in taking managerial decisions towards the mitigation and remedial measure against the environmental degradation. This course work addresses the modeling techniques for surface and ground water quality.

Prerequisite

Completion of Undergraduate level courses on Environmental engineering.

Course Outcomes

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

COS	Course outcomes	TCE Proficiency scale	Expected Proficiency (grade)	Expected Attainment level (%)
CO1	Understand the fundamental components of modeling and its applications of various water resources challenges	TPS2	B	80
CO2	Describe water and ground quality processes such as reaction kinetics, diffusion and eutrophication	TPS3	B	80
CO3	Apply the results of water and Exam ine surface water quality models such as QUAL 2K, and USGS models such as MODFLOW	TPS3	B	80
CO4	Use the basics of modeling to stratified lakes and reservoirs	TPS2	B	80
CO5	Principles of groundwater quality modeling	TPS2	B	80
CO6	Illustrate problem solving skills including model calibration, validation, and verification	TPS3	C	70

Mapping with Programme Outcomes

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

S-Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
CO1	5	25	-	-	-	-	-	-	-	-	-	-	2	10	-	-	-	-	-	-	50		-	-	-	-	-	-	-	-
CO2	5	10	20	-	-	-	-	-	-	-	-	-	2	10	10	-	-	-	-	-	25		-	-	-	-	-	-	-	-
CO3	5	10	20	-	-	-	-	-	-	-	-	-	2	10	10	-	-	-	-	-	25		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	10	25	-	-	-	-	2	10	-	-	-	-	-	-	-	-	-	-	-		50	-	-	-
CO5	-	-	-	-	-	-	10	25		-	-	-	2	10		-	-	-	-	-	-	-	-	-	-		25	-	-	-
CO6	-	-	-	-	-	-	-	10	20				-	10	10												25			

Syllabus

Modeling Concepts: Introduction: Water Quality-Fundamental Quantities-Mathematical models, Historical Development of Water-Quality Models.- Basic modeling concepts - Reaction Kinetics-Reaction fundamentals-Analysis of Rate Data-Stoichiometry-Temperature Effects.- Completely Mixed Systems (Lakes)- Mass Balance , Applied Loadings, Step Input, Impulse Input.- Plug Flow Systems (Rivers): Types, Hydro geometry- Low-flow Analysis. Dispersion and Mixing - Flow, Depth and velocity-Routing and Water Quality.-Estuaries: Estuary transport-Net Estuarine Flow-Estuary Dispersion coefficient-Vertical Stratification. **Mass Transfer at Air-Water –soil Interface:** Dissolved Oxygen Modeling - Reaeration - Carbonaceous BOD, Nitrogenous BOD, Photosynthesis/Algal Respiration, Benthal Demands.- Sediments: Sediment transport overview- Suspended Solids-the Bottom Sediments-Simple Solids Budgets-Bottom Sediments as a Distributed Systems - Resuspension..- The Water Quality Modeling Process- Model Sensitivity.- Presentations of Case Study information and USEPA Water Quality Model QUAL2K. **Properties, Principles and Geology of Groundwater:** Hydraulic head and fluid potential, Hydraulic Conductivity and Permeability, heterogeneity and Anisotropy of hydraulic Conductivity - porosity, void ratio, unsaturated flow and water table.- Aquifers and Aquitards - Steady state flow and Transient flow-Transmissivity and Storativity, Equation of ground water flow-Limitation of Darcian Approach-Hydrodynamic dispersion.- Groundwater Geology: Lithology, Stratigraphy and Structure, Fluvial Deposits, Aeolian Deposits, Glacial Deposits, Sedimentary Rocks. **Solute Transport Modeling:** Transport processes: Non-reactive constituents in homogenous and heterogeneous media –Governing equations.- Hydrochemical behavior of contaminants-Nitrogen, trace metals organic substances.- Measurement of parameters: Determination of Velocity, Dispersivity and chemical partitioning -sources of contamination Presentation of case study - USGS Models.

Course Contents and Lecture Schedule

S.No	Topics	No. of Lectures	CO
1. Modeling Concepts			
1.1	Introduction, Water Quality - Fundamental Quantities - Mathematical models, Historical Development of Water-Quality Models.	2	CO1
1.1.1	Basic modeling concepts - Reaction Kinetics **-** Reaction fundamentals - Analysis of Rate Data - Stoichiometry -Temperature Effects	2	CO1
1.2	Completely Mixed Systems (Lakes) - Mass Balance, Applied Loadings, Step Input, Impulse Input	2	CO1

1.3	Plug Flow Systems (Rivers): Types, Hydro geometry- Low-flow Analysis	2	CO2
1.3.1	Dispersion and Mixing - Flow, Depth and velocity - Routing and Water Quality.	2	CO2
1.4	Estuaries: Estuary Transport - Net Estuarine Flow - Estuary Dispersion Coefficient - Vertical Stratification	2	CO2
2. Mass Transfer at Air-Water –soil Interface			
2.1	Dissolved Oxygen Modeling - Reaeration - Carbonaceous BOD, Nitrogenous BOD Demands	2	CO3
2.2	Photosynthesis / Algal Respiration, Benthal Modeling	2	CO3
2.3	Sediments: Sediment transport overview - Suspended Solids -the Bottom Sediments - Simple Solids Budgets - Bottom Sediments as a Distributed Systems - Resuspension.	1	CO3
2.4	MIKE Hydro river-MIKE SHE-FEFLOW applications-case studies	1	CO4
2.5	The Water Quality Modeling Process- Model Sensitivity.	2	CO4
2.6	Presentations of Case Study information and USE PA Water Quality Model QUAL2K	4	CO4
3. Properties, Principles and Geology of Groundwater			
3.1	Hydraulic head and fluid potential, Hydraulic Conductivity and Permeability, heterogeneity and Anisotropy of hydraulic Conductivity- porosity, void ratio, unsaturated flow and water table	2	CO4
3.2	Aquifers and Aquitards-Steady state flow and Transient flow-Transmissivity and Storativity, Equation of ground water flow-Limitation of Darcian Approach-Hydrodynamic dispersion	1	CO4
3.3	Groundwater Geology: Lithology, Stratigraphy and Structure,	1	CO5
	Fluvial Deposits, Aeolian Deposits, Glacial Deposits, Sedimentary	1	CO5
4. Solute Transport Modeling			
4.1	Transport processes: Non - reactive constituents in homogenous and heterogeneous media–Governing equations.	2	CO5
	Hydro chemical behavior of contaminants - Nitrogen, trace metals organic substances	1	CO6
4.2	Measurement of parameters: Determination of Velocity, Dispersivity and chemical partitioning - sources of contamination	2	CO6
4.3	Presentation of case study-USGS Models	2	CO6
	Total Periods	36	

Reference Books

1. AllenFreeR.andJohnA.Cherry,-GroundwaterPrinticeHallInc.1979
2. StevenC.Chapra,Surface Water Quality Modelling, The McGraw - Hill Companies,Inc.,NewDelhi,1997.

Course Designers

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Ms.K.Keerthy kkciv@tce.edu

22CERQ0	COMPUTATIONAL INTELLIGENCE FOR HYDROSYSTEMS

CATEGORY	L	T	P	CREDIT
PEES	3	0	0	3

Preamble

To develop skills of the students in the software application for simulation in Water resources management. To enable the students to understand application of the latest Information Technology tools available in water resources engineering .

Course Outcomes

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

CO	Course Outcome	TCE Proficiency scale	Expected Attainment level (%)	Expected Proficiency (Grade)
CO1	To introduce the computational knowledge in the field of water resources systems.	TPS2	90	A
CO2	To comprehend Optimization concepts for water resource system planning and management	TPS2	85	B
CO3	To apply Decision support system in water resource system planning and management	TPS3	85	A
CO4	Understand better data management and analysis concept	TPS2	85	B
CO5	Understand role of IT in water resource management and use the latest intelligent technology and algorithms.	TPS2	85	A
CO6	To apply the simulation models in water resource management	TPS3	85	B

Mapping with Programme Outcomes

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

S - Strong; M - Medium ; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	10	20	-	-	-	-	-	-	-	-	-	-	2	10	-	-	-	-	-	-	25		-	-	-	-	-	-	-	-
CO2	5	20	-	-	-	-	-	-	-	-	-	-	2	10	-	-	-	-	-	-	25		-	-	-	-	-	-	-	-
CO3	5	20	20	-	-	-	-	-	-	-	-	-	2	10	15	-	-	-	-	-	50		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	10	20	-	-	-	-	2	10	-	-	-	-	-	-	-	-	-	-	-		25	-	-	-
CO5	-	-	-	-	-	-	5	20	-	-	-	-	2	10	-	-	-	-	-	-	-	-	-	-	-		25	-	-	-
CO6	-	-	-	-	-	-	5	20	20	-	-	-	-	10	15	-	-	-	-	-	-	-	-	-	-		50	-	-	-

Syllabus

Advanced computing techniques : Computer methods in water resources – Computing techniques - Solution to ordinary and partial differential equation using Finite difference and Method of Characteristics - Numerical integration and differentiation Design of digital models - Visual programming - Graphical user interface - Interactive model concepts. **Water resource system planning and management**: System component, planning and management-Optimisation and Simulation-Linear programing and applications-Dynamic programming and applications- multi objective optimization- stochastic optimization - Decision Support System- multicriteria decision making- expert system. **Digital data management** Database structure - Data acquisition - Data ware house - Data Retrieval - Data Format Attribute - RDBMS - Data analysis - Network data sharing - Statistical Analysis (SYSTAT) - Regression - factor analysis - histogram - scatter diagram - Goodness of fit. **Artificial intelligence** Heuristic search - Principle of Artificial Neural Network (ANN) - Application of ANN Model to Hydrology and Crop Water Requirement model. Fuzzy Logic concepts and Applications – Genetic Algorithms - Heuristic Optimization techniques. **Simulation software in water resources**: Water Resources Information System, Management Information System - Surface water models (HMS) - Storm Water Management Models (SWMM) - Case studies- River Analysis system models (HEC-RAS)-Ground Water Flow models–Ground water transport models.

Course Contents and Lecture Schedule

S. No	Topics	No. of Lectures	CO
	1. Advanced computing techniques		
1.1	Computer methods in water resources	1	CO1
1.2	Computing techniques	1	CO1
1.3	Solution to ordinary and partial differential equation using Finite difference and Method of Characteristics	2	CO1
1.4	Numerical integration and differentiation Design of digital models	2	CO1
1.5	Visual programming - Graphical user interface	1	CO2
1.6	Interactive model concepts	1	CO2
	2. Water resource system planning and management		
2.1	System component, planning and management	1	CO2
2.2	Optimization and Stimulation	1	CO2
2.3	Linear programing and applications	1	CO2

2.4	Dynamic programming and applications	1	CO3
2.5	multi objective optimization- stochastic optimization	1	CO3
2.6	Decision support system - multi criteria decision making - expert system.	2	CO3
	3. Digital data management		
3.1	Data base structure	1	CO3
3.2	Data acquisition- Data warehouse	1	CO3
3.3	Data retrieval-Data format Attribute – RDBMS	1	CO4
3.4	Data analysis - Network data sharing	1	CO4
3.5	Statistical Analysis (SYSTAT)	1	CO4
3.6	Regression - factor analysis	1	CO4
3.7	histogram - scatter diagram - Goodness of fit.	1	CO4
	4. Artificial intelligence		
4.1	Heuristic search	1	CO5
4.2	Principle of Artificial Neural Network (ANN)	1	CO5
4.3	Application of ANN Model to Hydrology model.	1	CO5
4.4	Fuzzy Logic concepts and Applications	2	CO5
4.5	Genetic Algorithms	1	CO5
4.6	Heuristic Optimization techniques	1	CO5
	5. Simulation software in water resources		
5.1	Water Resources Information System, Management Information System.	1	CO5
5.2	Surface water models (HMS)	1	CO5
5.3	Storm Water Management Models (SWMM) - Case studies	2	CO6
5.5	River Analysis system models (HEC-RAS)	1	CO6
5.6	Ground Water Flow models – Groundwater transport models.	2	CO6
	Total	**36**	

References Books

1. AlievR.A,andAlievRashad "Soft Computing and its Applications World Scientific Publications" Co.Pte.Ltd.Singapore,2001.
2. JanuszKacprzyk "Applied Decision with Soft Computing" Springer,2003.
3. CarlosA.Coello Coello, DavidAVanVeldhuizen, GaryBLamont, "Evolutionary Algorithms for Solving Multi - objective problems",Springer,2002.
4. TayfurGökmen "Soft computing in water resources engineering", WIT Press, Great Britain,UK, 20124.
5. JohnE.Gribbin, "Introduction to hydraulics and hydrology with applications for Storm waterManagement". DELMAR,ThomsonLearning,USA,2002.
6. RemsonI, Hornberger G.M. and MoizF.J., "Numerical methods in Sub - Surface Hydrology". WileyInterScience,1985

Course designer:

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Dr.S.Chandran schandran@tce.edu

22CERR0	CONSTRUCTION EQUIPMENT MANAGEMENT

Category	L	T	P	Credit
PEES	2	1	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 optimizing 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:

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Select an appropriate equipment for a specific purpose	TPS3	B	70
CO2	Estimate various cost components of equipment for different specifications	TPS3	B	70
CO3	Adapt suitable financing methods by considering equipment replacement strategies	TPS3	B	70
CO4	Select the optimum productive equipment among available specifications	TPS3	B	70
CO5	Apply the concept of scheduling for horizontal and vertical construction projects	TPS3	B	70
CO6	Explain the methodology of equipment maintenance program.	TPS2	B	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	4	4	20	-	-	-	-	-	-	-	-	-	2	2	10	-	-	-	-	-	20		-	-	-	-	-	-	-	-
CO2	4	2	30	-	-	-	-	-	-	-	-	-	2	-	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	4	2	30	-	-	-	-	-	-	-	-	-	2	2	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	4	-	20	-	-	-	2	-	10	-	-	-	-	-	-	-	-	-	-		20	-	-	-
CO5	-	-	-	-	-	-	4	4	30	-	-	-	2	2	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO6	-	-	-	-	-	-	4	4	30	-	-	-	2	2	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-

Syllabus

Role of Heavy Equipment in Construction- 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 Cost of Owning and Operating Construction Equipment - Ownership cost, Depreciation, Operating cost, calculation methods; Equipment Life and Replacement Procedures - Physical, profit and economic life, Replacement analysis and selection, Equipment Financing Decisions–Fundamental Concepts of Equipment economics - Financing methods, Rental and lease contract considerations; Optimizing Construction Equipment Productivity - Peurifoy's method of optimizing productivity, Phelps' Method, Load growth curve, Stochastic methods for estimation of productivity; Scheduling Equipment Intensive Projects - Horizontal Construction-Linear scheduling method, Precedence diagramming method, Vertical Construction-lifting for high rise work, Erection-dismantling, concrete placing cranes; Construction Equipment Maintenance- Need and Designing a Maintenance Program

Text Book

1. Gransberg,D.G.,Popescu,C.M.,andRyan,R.C.,"Constructionequipmentmanage mentforengineers,estimators,andowners",Taylor&Francis,NewYork,2006.

Reference Books& web resources

1. Peurifoy,R.L.,Schexnayder,C.J.,Shapira,A.,andSchmitt,R.,"Constructionplanning ,equipment,andmethods", 8thed.,McGrawHill,NewYork,2010.
2. SharmaS.C.,"Constructionequipmentandmanagement,KhannaPublishers,New Delhi,2011.
3. Day,D.A.and.Benjamin,N.B.H.,"Constructionequipmentguide",2ndedition,Wiley Publications, NewJersey,1991.
4. Equipment economics-https://nptel.ac.in/courses/105103023/
5. https://www.constructionequipment.com/
6. https://www.nbmcw.com/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**Introduction**		
1.1	Role of Heavy Equipment in Construction-Earthmoving Equipment Selection - Bulldozers, Front-end Loaders, Scrapers, Trucks	1	**CO1**
1.2	Excavating Equipment Selection-Excavators, Backhoes, Front shovels	1	
1.3	Lifting Equipment Selection- Cranes and Forklifts	1	
1.4	Other Equipment-Piles and Pile Driving Equipment, Production of Crushed-stone Aggregate, Concreting Equipment, Asphalt Mix Production and Placement Equipment.	1	
2	**Ownership and Operating cost of equipment**		
2.1	Ownership cost–depreciation cost	1	**CO2**
	Tutorials	2	
2.2	Cost of operating construction equipment	1	
	Tutorials	2	
2.3	Other methods- Corps of engineers, AGC, Peurifoy	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	1	**CO3**
3.3	Replacement equipments election	1	
4	**Equipment Financing Decisions**		
4.1	Fundamental concepts of equipment economics	1	**CO4**
4.2	Financing Methods- Buy, rent and lease	1	
	Tutorials	2	
5	**Optimizing Construction Equipment Productivity**		
5.1	Peurifoy's & Phelps Method	1	
	Tutorials	2	
5.2	Load growth curve	1	
	Tutorials	2	
5.3	Stochastic Methods	1	
6	**Scheduling Equipment Intensive projects**		
6.1	Horizontal Construction Projects- Linear scheduling method, Precedence diagramming method	3	**CO5**
	Tutorials	2	
6.2	Vertical Construction Projects- lifting for high rise work, Erection-dismantling, concrete placing cranes	2	
7	**Construction Equipment Maintenance**		
7.1	Need for a maintenance program	2	**CO6**
7.2	Designing a Maintenance Program	2	
	Total Hours		**36**

Course Designer(s):

1. Dr.G.Chitra, gcciv@tce.edu
2. Ms. M. Aruna, maciv@tce.edu

22CERS0	QUANTITATIVE METHODS IN MANAGEMENT

Category	L	T	P	Credit
PEES	2	1	0	3

Preamble

Decision making in today's social and business environment has become a complex task. The uncertainty of the future and the nature of competition and social interaction greatly increase the difficulty of managerial decision making. This course work on quantitative methods is an aid to decision making which offers the decision-maker a method of evaluating every possible alternative by using various techniques to know the potential outcomes.

Prerequisite

Nil

Course Outcomes

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

COs	Course Outcome Statements	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Formulate problems mathematically using the concept of Linear Programming (LP)	TPS 3	B	65
CO2	Solve problems by graphical, Simplex method, Artificial Variable Technique–Big M method	TPS 3	A	75
CO3	Solution of LP problems by Artificial variable technique-Two phase technique, Duality concept; identify the special cases in obtained solution	TPS 3	A	75
CO4	Solve transportation, assignment and traveling salesman problems	TPS 3	A	75
CO5	Apply Dynamic Programming to solve shortest route problems, capital budgeting problems and LPP	TPS 3	B	65
CO6	Apply game and decision theories to problems and understand the principle of Monte-Carlo simulation	TPS 3	B	65

Mapping with Programme Outcomes

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

S - Strong; M - Medium; L - Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	5	20	-	-	-	-	-	-	-	-	-	2	5	10	-	-	-	-	-	30		-	-	-	-	-	-	-	-
CO2	5	-	30	-	-	-	-	-	-	-	-	-	2	-	15	-	-	-	-	-	30		-	-	-	-	-	-	-	-
CO3	5	-	30	-	-	-	-	-	-	-	-	-	2	-	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	-	30	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-
CO5	-	-	-	-	-	-	5	5	30	-	-	-	2	-	15	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-
CO6	-	-	-	-	-	-	5	5	15	-	-	-	2	5	10	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-

Syllabus

Mathematical Modeling in OR: Decision Making in Operations Research. The art and science of Operations Research - Elements of a decision model - art of modeling - Types of models -effect of data available on modeling - computations in OR - Phases of OR study. **Systems Design:** Problem formulation - conversion of statement problems into LPP standard format. **Linear Programming Problem:** Definition and properties of Linear Programming Problem, Standard form -Graphical solution of two variable problems, special cases. Simplex method - computational procedure & problems. Artificial variables - Big Mand two phase Techniques, Special cases in Simplex method. **Linear Programming Applications:** Duality concept, primal & dual properties. Transportation problems - Vogel's Approximation method, Determination of optimum solution. Assignment Problem - Hungarian method of solution, Traveling salesman problem. Applications to Civil Engineering problems. **Dynamic Programming:** Multistage decision process, Bellman's principle of optimality — Computational procedure — Illustrating Tabular method of solution — Computational procedure - Shortest route problem, Capital budgeting problem – Solution of Linear Programming Problem by Dynamic Programming. **Other Techniques:** Game theory–procedure and problems, Decision theory - procedure and problems. Simulation – Monte Carlo simulation –brief concept

References

1. HamdyA.Taha,"OperationsResearch,AnIntroduction",PrenticeHall ofIndiaPvt.Ltd., NewDelhi-2013
2. PremKumarGuptaandD.S.Hira."ProblemsinOperationsResearch", S.Chand&CoPvtLtd,2015
3. S.S.Rao,"Optimization-TheoryandApplications",NewAgeInternational(P)Ltd.,Publishers2001
4. N.KrishnaRajuandK.U.Muthu,"NumericalMethodsinEngineeringProblems",McMilanIndiaLtd.,1996

Course Content and Lecture Schedule

Module No.	Topic	No. of Lectures	Course Outcomes
1.0	**Decision Making in OR**		
1.1	Optimization – meaning. Elements of OR Model	1	CO1
1.2	Art of modeling and types of OR models		
1.3	Phases of OR model		
1.4	**Linear Programming Problem -** Definition and Properties of Linear Programming Problem, Standard form. Mathematical Formulation of OR problems	2	
	Tutorial	2	
2.0	**Solution of LPP by Regular Simplex method**		
2.1	Graphical solution of two variable problems - Special cases in graphical method	2	CO2
2.2	Simplex method – computational procedure and problem solving	2	
	Tutorial	2	
3.0	**Solution of LPP by Artificial Variable Method and Duality concept**		CO3
3.1	Artificial variable Technique – M technique - procedure	2	

3.2	Artificial variable Technique- Two phase technique - Procedure & problems	2	
3.3	Duality concept - Primal & dual properties, Conversion of primal to dual problems	2	**CO3**
3.4	Special cases in Simplex method – Degeneracy, Alternative optima, Un - bonded solution, infeasible	1	
	Tutorial	2	
4.0	**Transportation problems**		
4.1	Transportation problems- objectives- Vogel's Approximation method,	2	**CO4**
4.2	Assignment Problem - objective, Hungarian method of solution – problems	2	
4.3	Traveling salesman problem - concept and procedure		
	Tutorial	2	
5.0	**Dynamic Programming**		
5.1	Multistage decision process – Bellman's principle Shortest route problem – computational procedure -Problems	2	**CO5**
5.2	Capital budgeting problem–Computational	2	
5.3	Solution of Linear Programming Problem by Dynamic Programming – problem	2	
	Tutorial	1	
6.0	**Other techniques**		
6.1	Game theory – procedure and problems	1	**CO6**
6.2	Decision Theory - procedure and problems	1	
6.3	Simulation – Monte Carlo simulation – brief concept	1	
	Total Periods	**36**	

Course designers:

1. Dr.G.Chitra, gc
2. Ms. M. Aruna, ma

22CERT0	CONTRACTS AND ARBITRATION

Category	L	T	P	Credit
PEES	2	1	0	3

Preamble

This course will create awareness on contracts for construction Industry; Impart knowledge on tender preparation, tendering process, Labour regulations, laws on arbitration, arbitration procedure and laws on dispute resolution in India

Prerequisite

NIL

Course Outcomes

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

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Choose the types, essentials and clauses of construction Contracts with their legal aspects and provisions	TPS3	B	70
CO2	Prepare the tender and contract document based on the technical, contractual and commercial perspectives of the construction industry	TPS3	B	70
CO3	Solve the issues related to tendering and contracting process in the construction industry	TPS3	B	70
CO4	Demonstrate the need and importance of labour regulations in the construction industry based on the given situation	TPS3	B	70
CO5	Suggest suitable type of Alternate dispute resolution for the given situational problem in the Construction Industry	TPS3	B	70
CO6	Illustrate the rules, proceedings and background of Arbitration in the Construction Industry	TPS3	B	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	4	4	20	-	-	-	-	-	-	-	-	-	2	5	10	-	-	-	-	-	20		-	-	-	-	-	-	-	-
CO2	4	2	30	-	-	-	-	-	-	-	-	-	2	-	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	2	4	30	-	-	-	-	-	-	-	-	-	2	-	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	2	4	20	-	-	-	2	5	10	-	-	-	-	-	-	-	-	-	-		20	-	-	-
CO5	-	-	-	-	-	-	4	4	30	-	-	-	2	-	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO6	-	-	-	-	-	-	4	2	30	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-

Syllabus

Introduction to contracts in construction industry: Brief details of Engineering contracts – definition, types and essentials of contracts and clauses for contracts – Preparation of tender and contract documents – prequalification, bidding, accepting, evaluation of tender form – technical, contractual and commercial point of view and standard contract documents – International contract document, World bank procedures and guidelines, Law of Torts – Issues related to tendering process- Awarding contract, e-tendering process - Time of performance – provisions of contract law – Breach of contract. Performance of Contracts – Discharge of a contract- Indian Contract Act 1872 – Risk management in contracts. **Laws related to Construction Industry** – Labour and industrial laws - payment of wages act, contract labour – Workmen's compensation act – Insurance and safety regulations, Industrial dispute act, Indian factory act, Child labour act and other labour laws. **Alternate Dispute resolution** – Litigation in Indian courts, Dispute resolution mechanism under the Indian judicial System. **Arbitration, Negotiation, Mediation and Conciliation** – concepts and purpose, Statutory back ground ADR and mediation rules, duties of mediator and disclose facts, power of court in mediation, Case studies, Duties of conciliator and negotiator. **Arbitration of Engineering Contracts** – Background of Arbitration in India, The Arbitration and conciliation Act 1996, UNCITRAL model law, Forms of arbitration – arbitration agreement, subject matter and violations, Commencement of arbitral proceedings, constitution of arbitral tribunal, appointment of arbitrator and rules of evidence, Institutional procedure of arbitration, Independence of arbitrators jurisdiction of arbitral tribunal, Interim measures, Enforcement of awards and cost.

Text Book

1. Indian Contract Act 1872, https://legislative.gov.in/sites/default/files/A1872-09.pdf

Reference Books& web resources

1. AmericanArbitrationAssociation,"Constructionindustryarbitrationrulesandmediationprocedures",2007
2. Collex.K,"ManagingConstructionContracts",Restonpublishingcompany,Virginia,1982
3. Gajaria. G.T, " Laws relating to building and Engineer's Contracts", M.M. Tripathi Pvt Ltd.,Mumbai,1985
4. Park.W.B.,"ConstructionBiddingforProjects",JohnWiley,Norway,1978
5. Vasavada.B.J."EngineeringContractsandArbitration",March1996
6. The Arbitration and Conciliation(Amendment)Act,2015

Course Contents and Lecture Schedule

Module No.	Topic	No.of Lectures	Course Outcome
1.0	**Introduction to contracts**		
1.1	Brief details of Engineering contracts	1	CO1,CO2,CO3
1.2	Types, Essentials of contracts and clauses of contract	1	
1.3	Preparation of tender and documents – prequalification, bidding, accepting, evaluation of tender form – technical, contractual and commercial point of view and standard contract documents.	3	
1.4	International contract document, World bank procedures and guidelines, Law of Torts	2	
1.5	Issues related to tendering process – Awarding contract, e-tendering process	2	
1.6	Time of performance – provisions of contract law – Breach of contract	2	

1.7	Performance of Contracts – Discharge of a contract–Indian Contract Act 1872, Risk management in contracts.	3	
2.0	**Laws related to Construction Industry**		
2.1	Labour and industrial laws – payment of wages act, contract labour.	2	CO4
2.2	Workmen's compensation act – Insurance and safety regulations	2	
2.3	Industrial dispute act, Indian factory act, Child labour act and other labour laws	1	
3.0	**Alternate Disputere solution**		
3.1	Litigation in Indian courts, Disputere solution mechanism under the Indian judicial System	2	CO5
3.2	Arbitration, Negotiation, Mediation and Conciliation – Concepts and purpose	3	
3.3	Statutory background ADR and mediation rules, duties of mediator and disclose facts, power of court in mediation.	2	
3.4	Case studies.	2	
4.0	**Arbitration of Engineering Contracts**		
4.1	Background of Arbitration in India, The Arbitration and conciliation Act 1996, UNCITRAL model law,	2	CO6
4.2	Forms of arbitration – arbitration agreement, subject matter and violations	1	
4.3	Commencement of arbitral proceedings, constitution of arbitral tribunal, appointment of arbitrator and rules of evidence	2	
4.4	Institutional procedure of arbitration	2	
4.5	Independence of arbitrators jurisdiction of arbitral tribunal, Inter immeasures, Enforcement of awards and cost.	1	
	TOTALHOURS	**36**	

Course Designer(s):

1. Dr.G.Chitra gcciv@tce.edu
2. Mr. B. Dinesh Kumar bdkciv@tce.edu

22CERU0	LEAN CONSTRUCTION

Category	L	T	P	Credit
PEES	3	0	0	3

Preamble

Lean Construction is an essential shift from conventional construction management. Lean approach seeks to improve project delivery by minimizing waste and maximizing value to the customer. This course has been intended to impart the key concepts, tools, and practices to improve the construction processes.

Prerequisite

Nil

Course Outcomes

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

COs	Course Outcome Statements	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Compare the concepts of Lean Production and Lean construction systems	TPS 2	A	75
CO2	Classify wastes in construction and apply lean techniques for waste reduction.	TPS 3	A	75
CO3	Apply Integrated Project Delivery principles in construction projects	TPS 3	A	75
CO4	Apply Collaborative planning techniques in construction projects	TPS 3	A	75
CO5	Apply various lean tools for planning, measuring the performances to ensure continuous improvement in construction projects	TPS 3	B	65
CO6	Summarize the importance of workplace organization, need for using Games for implementing lean concepts	TPS 3	B	65

Mapping with Programme Outcomes :

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

S-Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	15	-	-	-	-	-	-	-	-	-	-	2	5	10	-	-	-	-	-	30		-	-	-	-	-	-	-	-
CO2	5	10	30	-	-	-	-	-	-	-	-	-	2	-	15	-	-	-	-	-	30		-	-	-	-	-	-	-	-
CO3	5	-	30	-	-	-	-	-	-	-	-	-	2	-	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	5	20	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-
CO5	-	-	-	-	-	-	5	10	20	-	-	-	2	-	15	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-
CO6	-	-	-	-	-	-	5	10	20	-	-	-	2	5	10	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-

Syllabus

Introduction to contracts in construction industry: Brief details of Engineering contracts – definition, types and essentials of contracts and clauses for contracts – Preparation of tender and contract documents – prequalification, bidding, accepting, evaluation of tender form – technical, contractual and commercial point of view and standard contract documents – International contract document, World bank procedures and guidelines, Law of Torts – Issues related to tendering process- Awarding contract, e-tendering process - Time of performance – provisions of contract law – Breach of contract. Performance of Contracts – Discharge of a contract- Indian Contract Act 1872 – Risk management in contracts. **Laws related to Construction Industry** – Labour and industrial laws - payment of wages act, contract labour – Workmen's compensation act – Insurance and safety regulations, Industrial dispute act, Indian factory act, Child labour act and other labour laws. **Alternate Dispute resolution** – Litigation in Indian courts, Dispute resolution mechanism under the Indian judicial System. **Arbitration, Negotiation, Mediation and Conciliation** – concepts and purpose, Statutory back ground ADR and mediation rules, duties of mediator and disclose facts, power of court in mediation, Case studies, Duties of conciliator and negotiator. **Arbitration of Engineering Contracts** – Background of Arbitration in India, The Arbitration and conciliation Act 1996, UNCITRAL model law, Forms of arbitration – arbitration agreement, subject matter and violations, Commencement of arbitral proceedings, constitution of arbitral tribunal, appointment of arbitrator and rules of evidence, Institutional procedure of arbitration, Independence of arbitrators jurisdiction of arbitral tribunal, Interim measures, Enforcement of awards and cost.

References

TEXTBOOKS:

1. The Toyota Way Field book, Jeffrey Liker and David Meier, McGraw-Hill, 2006. Lean Production Simplified, Pascal Dennis, Productivity Press,2007.
2. Womack, JamesP., and Daniel T.Jones. Lean Thinking. NewYork, NY: Simonand Schuster, 2003. ISBN: 0743249275.
3. Murman,EarlI. Lean Enterprise Value. NewYork, NY: Palgrave Macmillan, ISBN: 0333976975.
4. Forbes and Ahmed (2011), "Modern Construction — Lean Project Delivery and Integrated Practices", CRC Press, Taylor & Francis Group, NewYork.
5. Patricia Tzortzopoulos, Mike Kagioglou and Lauri Koskela (2020)," Lean Construction — Core Concepts and New Frontiers", Routledge, Taylor & Francis Group, London and NewYork.
6. Liker and Meier (2006), "The Toyota Way", McGraw - Hill.
7. Supplementary modules (workbook and reading materials) on each topic will shared along with a weekly release of course contents

REFERENCES:

1. Readingsathttp://www.leanconstruction.org/readings.htm
2. Hopp,W.J.,andSpearman,M.L.(2011).FactoryPhysics,ThirdEdition,Wavel andPress,LongGrove,Il.720pp.
3. S. Karthikeyan, 2019. ME thesis, "Teaching LEAN Through Games and Simulation Tools", IITM, Chennai

Course Contents and Lecture Schedule :

Module No.	Topics	No. of Hours	Course Outcome
1.	**Lean–Evolution**		
1.1	Introduction – Lean Production - background and lean thinking.	2	**CO1**
1.2	Toyota Production System. Lean production philosophy	1	
1.3	Introduction to Lean Construction.	2	

	Difference between Lean Production and Lean Construction.		
2.	**Introduction to Lean construction**		
2.1	Lean Construction –Overview and Definition, Value Proposition	2	**CO2**
2.2	Waste in Construction, Terminologies in lean Construction	3	
3.0	**Concept of IPD and lean**		
3.1	Concepts of Integrated Project Delivery	2	**CO3**
3.2	Value stream mapping for construction processes, case studies	3	
3.3	Minimizing waste - value - add edvs. non-value added activities	2	
3.4	Integrated Project Delivery, Case study discussions	2	
4.0	**Lean Tools**		
4.1	Collaborative Planning – Master Planning, Make Ready Schedule. Production Planning Tools for Collaborative Planning	3	**CO4**
4.2	Measuring Performances – Plan Percent Complete - PPC	2	
5.0	**Other Lean Tools:**	**CO5**	
5.1	Workflow, Visual Management, 5S,	2	
5.2	Just - In - Time, Cycle time analysis	2	
5.3	ConstraintAnalysisandsolutionthroughA 3sheets,Continuousimprovement	2	**CO5**
5.4	Case study discussions	2	
6.0	**Lean culture in organization**		
6.1	Building Lean Culture in an Organization,	2	**CO6**
6.2	Human resources and managing change in organization, Team building and training	2	
	Total Periods	**36**	

Course Designers :

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22CERV0	MATERIAL PROCUREMENT AND MANAGEMENT

Category	L	T	P	Credit
PEES	2	1	0	3

Preamble

This course focuses on the core principles of project procurement management, material planning and evaluation methods of materials consumed in various infrastructure domains. Students are exposed to effective techniques for successfully allocating risks and delivering projects which help in acquiring future projects.

Prerequisite

Nil

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Explain the scope, functions, and importance of material procurement management in the construction industry	TPS2	B	70
CO2	Classify the materials of construction, compare the different sources of procurement, and conduct vendor analysis	TPS3	B	70
CO3	Select and apply inventory control technique needed for the effective management of Inventory in the	TPS3	B	70
CO4	Solve the problems on Economic ordering quantity considering order point control, safety stock, stock outs and discounts	TPS3	B	70
CO5	Apply site layout procedure and site organizational methods for the management of stores in the Construction Industry	TPS3	B	70
CO6	Apply statistical methods of sampling technique to compute the quality of material. Apply material management systems in planning, procurement, inventory and cost	TPS3	B	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	4	20	-	-	-	-	-	-	-	-	-	-	2	10	-	-	-	-	-	-	20		-	-	-	-	-	-	-	-
CO2	4	4	30	-	-	-	-	-	-	-	-	-	2	2	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	4	4	30	-	-	-	-	-	-	-	-	-	2	2	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	2	4	30	-	-	-	2	2	15	-	-	-	-	-	-	-	-	-	-		20	-	-	-
CO5	-	-	-	-	-	-	4	4	20	-	-	-	2	-	15	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO6	-	-	-	-	-	-	4	2	30	-	-	-	-	4	10	-	-	-	-	-	-	-	-	-	-		40	-	-	-

Syllabus

Introduction: Importance of material management and its role in construction industry, scope, objectives and functions - Integrated approach to material management - Role of materials manager. **Classification and Codification of materials of construction**: ABC, FSN, VED, SOS analysis - Procedure and its use, Standardization in materials and their management, Procurement - Identification of sources of procurement, vendor analysis. Materials Requirement Planning (MRP), Purchase procedure, legal aspects. **Inventory Management**: Store Purchase Manual - Contractors Obligation - Inventory Control techniques - EOQ, Advantages and limitation of use of EOQ, Periodic ordering, order point control, safety stock, stock outs, Application of ABC analysis in inventory control, Just in Time (JIT) Management, Indices used for assessment of effectiveness of inventory management. **Stores Management**: Receipt and inspection, care and safety in handling, loss on storage, wastage, Bulk purchasing, site layout and site organization, scheduling of men, materials and equipment. **Quality Control** – Conventional methods of quality control of Construction materials. Statistical methods of quality control, sampling techniques in quality control process - Quality management and economics. **Project procurement processes.** Materials Management Systems (MMS) and its scope in materials planning, procurement, inventory control, cost control etc.

Learning Resources

1. Chitale A.K. and R.C. Gupta, “Material Management – Text and Cases”, Prentice Hall of India Pvt. Ltd., 2007
2. Denise Bower, “Management of Procurement”, Construction Management Series, Thomas Telford Publishing, 2003
3. Jhamb L.C., “Inventory Management”, Everest Publishing house, 2005
4. Peter Holm Andreasen, “Dynamics of Procurement Management – A Complexity Approach”, Copenhagen Business School, 2012
5. Peter Baily, David Farmer, Barry Crocker, David Jessop & David Jones, “Procurement Principles and Management”, FT Prentice Hall, 2010
6. R.Paneerselvam, “Production and Operations Management”, Publisher prentice hall of India, 2012
7. NPTEL- Operations and Supply Chain Management: https://www.youtube.com/watch?v=9tJv5COGkD0

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	Course Outcomes
1.0	**Introduction to Material Procurement and Management**		
1.1	Need and Importance of material management and its role in construction industry	1	CO1
1.2	Scope, objectives and functions of material management, Integrated approach to materials management	2	
1.3	Role of materials manager		
2.0	**Classification and Codification of Materials of Construction**		
2.1	ABC, FSN -Procedure and its use	1	CO2
	VED, SOS analysis - Procedure and its use	1	
2.2	Standardization in materials and their management, Procurement, Identification of sources of procurement	1	
2.3	Vendor analysis concept of (MRKP) Material requirement planning, planning, purchase procedure, legal aspects	2	
	Tutorial on ABC analysis	2	
	Tutorial on Vendor analysis	2	
3.0	**Inventory Management**		
3.1	Inventory Control techniques – principle and applications	2	CO3
3.2	EOQ, Advantages and limitation of use of EOQ, Periodic ordering, order point control - problem solving	2	
	Safety stock, stock outs, application of ABC analysis in inventory control – problem solving	2	
3.3	Concept of Just in time management(JIT),Indices used for assessment of effectiveness of inventory management	1	
	Tutorial on EOQ	2	
	Tutorial in inventory control techniques	2	
4.0	**Stores Management**		
4.1	Receipt and inspection, care and safety in handling, loss on storage, wastage, Bulk purchasing	2	CO4
4.2	Site layout and site organization, scheduling of men, materials and equipment with problem solving in site layout	2	
5.0	**Quality Control**		
5.1	Quality Control – Conventional methods of quality control of Construction materials. Statistical method of quality control	2	CO5
	Sampling techniques quality control in process. Quality management and its economics	1	
	Tutorial – problem solving	2	
6.0	**Project procurement**		
6.1	Project procurement processes: Use of (MMS) – Materials Management Systems in materials planning,	2	CO6
	Procurement, inventory control, cost control	2	
	Total	**36**	

Course Designer(s):

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2. Ms. M. Aruna maciv@tce.edu

22CERW0	MANAGEMENT OF HUMAN RESOURCE, SAFETY AND QUALITY

Category	L	T	P	Credit
PEES	3	0	0	3

Preamble

This course will create awareness on the management of human resources, safety and quality for an organization; Impart knowledge on the functions, importance and various codes and standards available for managing human resources, safety and quality.

Prerequisite

Nil

Course Outcomes

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

COs	Course Outcomes	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Explain the functions, process and importance of Human resource Management in the Construction Industry	TPS2	B	70
CO2	Relate the grievances faced in a construction industry with the various codes and laws available in the human resource management and suggest suitable measures to solve them	TPS3	B	70
CO3	Interpret responsibilities of parties in organizations and apply appropriate practices to ensure safety in organizations	TPS2	B	70
CO4	Solve the safety related crisis in construction using the Ergonomics and OSHA Codes and Standards	TPS3	B	70
CO5	Explain the Elements, Characteristics, and the importance of ISO 9000 codes and standards of Quality in Construction Industry	TPS2	B	70
CO6	Compute the Quality of a product using statistical methods of quality control sampling technique	TPS3	B	70

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	4	20	-	-	-	-	-	-	-	-	-	-	2	10	-	-	-	-	-	-	20		-	-	-	-	-	-	-	-
CO2	4	4	40	-	-	-	-	-	-	-	-	-	2	-	20	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	4	24	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	2	2	30	-	-	-	2	-	20	-	-	-	-	-	-	-	-	-	-		20	-	-	-
CO5	-	-	-	-	-	-	4	24	-	-	-	-	2	10	-	-	-	-	-	-	-	-	-	-	-		40	-	-	-
CO6	-	-	-	-	-	-	4	4	30	-	-	-	2	-	20	-	-	-	-	-	-	-	-	-	-		40	-	-	-

Syllabus

Human Resources Management - Concept - Growth - Role and functions. Manpower Planning for Construction Companies - Line and Staff functions - Recruitment, selection, placement, induction and training - over staffing; Time office and establishment functions; wage and salary administration - Discipline - Separation Process. Labor Legislation- labor laws related to construction industry – Code of Ethics and Conduct - Interstate migration - Industrial relations - Collective bargaining - Worker’s participation in management. Grievances 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. Safety Implementation - Application of Ergonomics in the construction industry - prevention of fires at construction site - Safety audit, OSHA Codes and Standards for Construction Safety. Quality Management in Construction - Importance of quality - Elements of quality - quality characteristics - quality by design - quality conformance. ISO Codes and standards- ISO 9001-2000 Family of Standards- Benefits of ISO 9000- Quality Control and Assurance - identification and traceability for quality control. Documentation - Organization for quality control, Quality Control by statistical methods- Statistical Quality Control with sampling by attributes- Statistical Quality Control with sampling by variables - Importance of specifications- Incentives and penalties in specifications - Workmanship as a mark of quality. Quality assurance techniques - Inspection, testing, sampling, Cost of quality. Introduction to TQM, Lean Six Sigma and Sustainability.

Text Book

1. JosyJ.Farrilaro,“Hand Book of Human Resources Administration” McGrawHill (International Edition) 1987.

Reference Books& web resources

1. ManoriaC.B., “Personnel Management”, Himalaya Publishing House, 1992.
2. Arya Ashok “Discipline & Disciplinary procedure” Organisation Development Institute, 1998
3. Arya Ashok, “Management case studies – Ananalytical an Developmental Tool” Organisation Development Institute, NewDelhi, 1999
4. Malik,P.L., “Handbook of Labour & Industrial Law”, Eastern book company, Lalbagh, Lucknow, 2010
5. Grant E.L., and Leavensworth, “Statistical Quality Control”, McGrawHill, 1984.
6. Kumar NeerajJha, “Construction Project Management Theory and Practice”, Pearson, 2011.
7. Dr.S.Seetharaman, “Construction Engineering and Management Fifth Edition”, Umesh Publications, 2018
8. Construction Safety Manual for Works Contract – Bhabha Atomic Research Centre, Mumbai(BARC)
9. OSHA standards - Occupational Health and Safety Administration https://www.osha.gov/
10. NPTEL -Principles of Human Resource Management :https://nptel.ac.in/courses/110105069/
11. NPTEL-Principles of Construction management :https://nptel.ac.in/courses/105104161/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	Course Outcome
1.0	**Human Resources Management**		
1.1	Concept-Growth- Role and functions	1	CO1
1.2	Manpower Planning for Construction Companies - Line and Staff function	1	
1.3	Recruitment, selection, placement, induction and training -over staffing	1	

1.4	Time office and establishment functions; wage and salary administration	1	
1.5	Discipline- Separation Process	1	
2.0	**Labor Legislation**		
2.1	Labor laws related to construction industry	2	CO2
2.2	Code of Ethics and Conduct	1	
2.3	Interstate migration - Industrial relations - Collective bargaining	1	
2.4	Worker's participation in management	1	
2.5	Grievances handling–discipline	1	
2.6	Role of law enforcing agencies and judiciary - women in construction industry	1	
3.0	**Safety Management**		
3.1	Importance of safety-causes of accidents	2	CO3
3.2	Responsibility for safety - Role of various parties in safety management.	2	
3.3	Safety benefits. Approaches to improve safety in construction for different works. Safety Measurement	2	
4.0	**Safety Implementation**		
4.1	Application of Ergonomics to the construction industry	1	CO4
4.2	Prevention of fires at construction site, Site safety planning	1	
4.3	Safety Audit - OSHA Codes and Standards for Construction Safety	2	
5.0	**Quality Management in Construction**		
5.1	Importance of quality; Elements of quality	1	CO5
5.2	Quality characteristics - Quality by design - quality by conformance	2	
5.3	ISO Codes and standards - ISO 9001-2000 Family ofStandards-BenefitsofISO9000	2	
6.0	**Quality Control and Quality Assurance**		
6.1	Identification and traceability. Documentation - Organization for quality control	1	CO6
6.2	Quality Control by statistical methods - Statistical Quality Control with sampling by attributes - Statistical Quality Control with sampling by variables.	3	
6.3	Importance of specifications - Incentives and penalties in specifications-Workmanship as a mark of quality	1	
6.4	Quality Assurance - Inspection, testing, sampling, Cost of quality	2	
6.5	Introduction to TQM, Lean Six Sigma and Sustainability	2	
	Total Periods	**36**	

Course Designer(s):

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22CERX0	TRAFFICENGINEERINGAND MANAGEMENT

Category	L	T	P	Credit
PC	3	0	0	3

Preamble

Reliable and efficient traffic engineering management is crucial in our daily lives. This course imparts the student's, importance of transportation, various traffic engineering studies and traffic flow characteristics. The students will also acquire proficiency in the design of traffic facilities and also in efficient traffic management techniques. Further, students will be exposed to road safety aspects and studies

Prerequisite

Fundamentals of Highway and Railway Engineering

Course Outcomes

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

COS	Course Outcome Statement	TCE Proficiency Scale	Attainment level	Proficienc y level
CO1	Explain traffic flow and its characteristics	TPS3	B	65
CO2	Identify various traffic engineering studies	TPS3	B	65
CO3	Principles of road signs, markings, street furniture.	TPS2	B	65
CO4	Design of traffic signal	TPS3	B	65
CO5	Design of rotary intersection, principles of grade separators	TPS3	B	65
CO6	Explore techniques for traffic management	TPS2	B	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern:

CO	CAT1			CAT2			Terminal			Assignment 1			Assignment 2		
TPS Scale	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1	-	4	20	-	-	-		2	10	-		20	-	-	-
CO2	-	4	30	-	-	-		4	15	-		40	-	-	-
CO3	12	30		-	-	-	4	15		-	40		-	-	-
CO4	-	-	-		8	30		4	15	-	-	-	-	-	30
CO5	-	-	-		4	30		2	10	-	-	-	-	-	30
CO6	-	-	-	8	20		4	15		-	-	-	-	40	

Syllabus

Introduction: Significance and scope, Characteristics of vehicles and road users, Skid resistance and Braking Efficiency (problems). Components of Traffic Engineering- Road, traffic and land use characteristics **Traffic Surveys and analysis:** Traffic surveys- speed, journey time and delay surveys- vehicles, volume survey including non-motorized transport-Methods and interpretation- origin and destination surveys. Parking survey, pedestrian studies Accident analysis (Concepts and problems) Traffic Flow- Introduction to traffic flow theory, Level of service-concept, application and significance. **Traffic Control:** Traffic signs, Road markings, Design of traffic signals and signal co-ordination (Problems), Traffic control aids and street furniture, street lighting, Computer application in signal design. **Geometric design of Intersection:** Conflicts at Intersection, Classification of at grade intersection-Channelized Intersection. Principles of Intersection design. Elements of Intersection design, rotary design, Grade separation and Interchanges. **Traffic management:** Transportation system management (TSM) **–** Travel Demand Management (TDM)**-**Traffic management measures – Traffic calming measures -Introduction to Intelligent Transportation system (ITS).

Learning Resources

1. KadiyaliL.R,“Traffic Engineering and Transportation Planning”, Khanna Publishers, Delhi,9th Edition, 2017.
2. Khanna SK Justo CEG and Veeraragavan A, “Highway Engineering”, Nem Chand & Bros,Roorkee, Revised 10th Edition, 2018.
3. Brase/Brase“UnderstandableStatistics3rdedition”,DCHealthandCompany,Lexington ,Massachusetts,Toronko,1987.
4. Jason C.yu, Transportation Engineering: Introduction to Planning, Design and Operations,Elsevier,1992.
5. TaylorM.A.PandYoungW,TrafficAnalysis-NewTechnologyandNewsolutions,HargreenPublishingCompany,1998.
6. Nicholas J. Garben and LesterAHoel, “Traffic and Highway Engineering”, PWS Publication,1999.
7. http://www.nptel.ac.in/downloads/105101008/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	Course Outcome
1.0	**Introduction**		
1.1	Significance and scope	1	CO1
1.2	Characteristics of road users, PIEV theory	2	
1.3	Characteristics of the Vehicle (Problems)	1	
1.4	Skid resistance and Braking Efficiency (Problems)	2	
1.5	Components of Traffic Engineering- Road, traffic and land use characteristics	1	
2.0	**Traffic Surveys and analysis**		
2.1	Volume Studies	2	CO2
2.2	Speed and Delay Studies	1	
2.3	Origin and destination studies	1	
2.4	Parking and pedestrian studies	1	
2.5	Accident Studies and safety	1	
2.6	Capacity and Level of service	1	
2.7	Basic principles of traffic flow	2	
3.0	**Traffic Control**		
3.1	Traffic signs and road marking	2	CO3
3.2	Design of traffic signal and signal co-ordination	2	CO4
3.3	Traffic control aids and street furniture	1	CO3
3.4	Street lighting	1	
4.0	**Geometric Design of Intersection**		
4.1	Conflict at Intersection,	1	

4.2	Classification of at grade intersection- Chanalized Intersection.	2	CO5
4.3	Principles and elements of Intersection design	1	
4.4	Rotary design (problem),	2	
4.4	Grade separation and interchanges	1	
5.0	**Traffic Management**		
5.1	Transportation System Management (TSM)-Travel Demand management (TDM)	2	CO6
5.2	Traffic forecasting technique	1	
5.3	Restriction on turning movements, one-way street, tidal flow operations, exclusive bus-lanes	1	
5.4	Traffic calming,	1	
5.5	Introduction to Intelligent transport system	2	
	Total Hours	36 Hrs	

Course Designers:

1. Dr. R.Velkennedy rvkciv@tce.edu
2. Dr.K.Athiappan kanciv@tce.edu

22CERY0	PAVEMENT ANALYSIS AND DESIGN

Category	L	T	P	Credit
PEES	3	0	0	3

Preamble

The course aims to make the students learn the principles of Idea about various material used in pavement construction and their properties. Further students understand load distribution characteristics of flexible and rigid pavements and concept of development of stresses and strains within the pavement system. This also imparts Knowledge about pavement design methods of pavements and their components.

Prerequisite

Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Attainment level	Proficiency level
CO1	Understand about the pavement layers and factors considered for the design of pavements	TPS2	B	65
CO2	The concept of pavement evaluation and analysis	TPS2	B	65
CO3	The concept of development of stresses and strains within the flexible pavements	TPS3	B	65
CO4	Knowledge about flexible pavement design methods	TPS3	B	65
CO5	The concept of development of stresses and strains within the rigid pavements	TPS3	B	65
CO6	Knowledge about rigid pavement design methods	TPS3	B	65

*** Weightage depends on Bloom's Level, number of contact hours,

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern:

CO	CAT1			CAT2			Terminal			Assignment 1			Assignment 2		
TPS Scale	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	4	20		-	-	-	2	-	10	-	20	-	-	-	-
CO2	4	30		-	-	-	2	2	15	-	40	-	-	-	-
CO3		12	30	-	-	-	2	2	15	-	-	40	-	-	-
CO4	-	-	-	4	4	30	2	2	15	-	-	-	-		40
CO5	-	-	-	4	-	20	2	-	10	-	-	-	-		20
CO6	-	-	-	4	4	30	2	2	15	-	-	-	-		40

Syllabus

Introduction to Pavements: Types of pavements, Flexible and rigid pavements, Functions of individual layers, Factors considered in Pavement Design: Traffic factors, Material properties, Climatic effects Traffic Analysis: ADT, AADT, Truck Factor, Growth Factor, Lane Distribution and Vehicle Damage Factor**.** Bituminous Mix design – Marshall and SUPERPAVE method-Pavement quality Concrete **Pavement Evaluation and Maintenance:** Pavement Evaluation-Benkelman beam and Falling weight deflect meter - Overlay design, Pavement condition survey, Flexible and rigid pavement-failure, causes and treatment. **Stresses and strains in flexible pavements:** Stress inducing factors in flexible pavements, VehiclePavement interaction, Stresses and deflections in homogeneous soil mass, Load equivalency factor, Burmister's layer theory: Solutions for one, two and three layered pavement systems. **Methods of flexible pavement design:** Principles of Mechanistic- Empirical Pavement Design (MEPD), Methods of flexible pavement design: IRC Method. **Stresses in Rigid Pavements:** Westergaard's theory and assumptions, Types of stresses: Wheel load stresses, Temperature stresses, Critical combination of stresses. **Design of cement concrete pavements** Rigid pavement design methods: IRC method**.** Types of joints in cement concrete pavements – functions and requirements Joint spacing – Design of dowel bars and tie bars (IRC method). Introduction to softwares for design of pavements

Learning Resources

1. Yang H. Huang, Pavement Analysis and Design, 2nd Ed. Prentice Hall, 2003.
2. Yoder and Witczak, Principles of Pavement Design, John Wiley and sons, 2007.
3. Richard Kim Y, Asphalt pavements, CRC press, 2014.
4. Asphalt Institute. Mix Design Methods – For Asphalt Concrete and Other Hot-Mix Types.
5. Manual Series No. 2 (MS-2), Asphalt Institute, Kentucky, USA, 1997.
6. R. N. Hunter, Bituminous Mixtures in Road Construction, Thomas Telford Services Ltd 1995.
7. Atkins, H.N. Highway Materials, Soils, and Concretes, Reston Publishing Company, Virginia, USA, 4 th edition, 2002.
8. Bland, D.R. The Theory of Linear Viscoelasticity, Pergamon Press, New York, USA, 1960.
9. Christensen, R.M. Theory of Viscoelasticity – An Introduction, Academic Press, New York, USA, 1971.
10. IRC:44-2008 Guidelines for Cement Concrete Mix Design for Pavements, The Indian Roads Congress, New Delhi, India, 2008
11. Latest revisions of IRC codes: IRC: 37-2012 and IRC: 58 - 2013.
12. Manual for construction and supervision of Bituminous works, MoRTH 2001

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	Course Outcome
1.0	**Introduction to Pavements**		
1.1	Types of pavements- Flexible and rigid pavements	1	CO1
1.2	Functions of individual pavement layers	1	
1.3	Factors considered in Pavement Design: Traffic factors, Material properties, Climatic effects Traffic Analysis: ADT, AADT, Truck Factor, Growth Factor, Lane Distribution and Vehicle Damage Factor	2	
1.4	Bituminous Mix design – Marshall and SUPERPAVE method-Pavement quality concrete.	2	
2.0	**Pavement Evaluation and Maintenance**		
2.1	Pavement Evaluation-Benkleman beam and Falling weight deflect meter, Overlay design	2	CO2
2.2	Pavement condition survey	2	
2.3	Flexible and rigid pavement-failure, causes and treatment	2	
3.0	**Stresses and strains in flexible pavements**		
3.1	Stress inducing factors in flexible pavements, Vehicle Pavement interaction	2	CO3
3.2	Stresses and deflections in homogeneous soil mass, Load equivalency factor	2	
3.3	Burmister's layer theory: Solutions for one, two and three layered pavement systems	2	
4.0	**Methods of flexible pavement design**		
4.1	Principles of Mechanistic- Empirical Pavement Design (MEPD)	3	CO4
4.2	Methods of flexible pavement design: IRC Method,	3	
5.0	**Stresses in Rigid Pavements**		
5.1	Westergaard's theory and assumptions	2	CO5
5.2	Types of stresses: Wheel load stresses	2	
5.3	Temperature stresses, Critical combination of stresses.	2	
6.0	**Design of cement concrete pavements**		
6.1	Rigid pavement design methods: IRC method.	3	CO6
6.2	Types of joints in cement concrete pavements – functions and requirements Joint spacing – Design of dowel bars and tie bars (IRC method). Introduction to softwares for design of pavements	3	
	Total Hours	**36 Hrs**	

Course Designers:

1. Dr. R. Velkennedy rvkciv@tce.edu
2. Dr.K.Athiappan kanciv@tce.edu

22CERZ0	**DESIGN OF FOUNDATION AND SUBSTRUCTURE**	Category	L	T	P	Credit
		PEES	3	0	0	3

Preamble

This course aims at equipping students with adequate knowledge on design principles of sheet pile walls, analysis and design of raft foundation and design of pile foundations. Furthermore, students would be able to estimate the lateral resistance of piles, load carrying capacity, settlement of pile groups, design pile caps, stone columns and caisson foundation.

Prerequisite

Soil Mechanics and Foundation engineering

Course Outcomes

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

CO	Course Outcome	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Understand various types of sheet pile walls and design them.	TPS3	A	65
CO2	Explain the necessity of raft foundation and analyze them.	TPS3	A	65
CO3	Design piles subjected to vertical loads and pile caps.	TPS3	A	65
CO4	Estimate the capacity of batter piles, and analyze piles subjected to lateral loads and pile groups.	TPS3	A	65
CO5	Analyze and design caisson foundation.	TPS3	A	65
CO6	Analyze and design Braced cuts.	TPS3	A	65

Mapping with Programme Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern

Assessment	**CAT1**			**CAT2**			**Terminal Exam**			**Assignment 1**			**Assignment 2**		
TPS / **COs**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1	4	4	30	-	-	-	2	-	15	-	-	30	-	-	-
CO2	3	3	20	-	-	-	2	-	12	-	-	30	-	-	-
CO3	3	3	30	-	-	-	2	-	15	-	-	40	-	-	-
CO4	-	-	-	3	3	27	2	-	15	-	-	-	-		30
CO5	-	-	-	3	-	28	2	-	15	-	-	-	-		40
CO6	-	-	-	4	16	16	-	10	8	-	-	-	-		30

Syllabus

Sheet Pile Walls: Types of Sheet Piles, Design principles of Cantilever sheet pile wall, Anchored sheet pile wall, fixed earth support method for Anchored sheet pile wall, Equivalent beam method. **Raft Foundation**: Types of Raft foundation, Allowable pressures for raft in cohesive and cohesionless soils, Conventional design of raft foundation, Design of flat slab raft foundation, Design of beam and slab raft foundation. **Pile Foundation**: Structural design of Precast piles, Design of Cast in-situ piles, Design of under reamed piles, Design of stone columns, Batter piles for lateral loads – Culmann method, Graphical method, IS 2911 method of lateral resistance of vertical piles – Broms chart, **Pile Group:** Pile spacing and efficiency of pile group - Load carrying capacity of pile groups - Pile group subjected to eccentric vertical load - Settlement of pile group - Design of pile cap, Concept of piled raft. **Caisson Foundation**: Types of caisson foundation - Estimation of load bearing capacity of caisson foundation in cohesionless and cohesive soil - Stability Analysis by limit equilibrium method. **Braced cuts**: Lateral earth pressure in braced cuts-components of braced cuts-stability of braced cuts.

Text Book

1. Varghese. P.C., “Foundation Engineering”, Prentice Hall of India Private Limited, New Delhi,2012.

Reference Books & Web Resources

1. Braja M. Das, Nagaratnam Sivakugan., “Principles of Foundation Engineering”, Nineth Edition,2016 (India),Thomson.
2. Murthy, V.N.S., “Advanced Foundation Engineering”, CBS Publishers & Distributors, New Delhi,2007.
3. Prakash S., and Sharma, H. D., “Pile Foundations in Engineering Practice.” John Wiley & Sons, New York,1990
4. Bowles J.E., “Foundation analysis and design”, Tata McGraw Hill, New Delhi,2005.

List Of National And International Standards

1. IS: 2911 Part 1 (Section: 4) -1984, Code of practice for Design and Construction of pile foundation. Part 1 –Concrete Piles, Section 4-Bored cast in-situpiles.
2. IS: 2950 (Part 1) -1981, Code of Practice for Design and construction of raft. 3 .IS 15284-(Part 1)- 2003, Design and construction for ground improvement- Guidelines, Part 1: Stone columns.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**Sheet Pile Walls**		
1.1	Types of Sheet Piles	1	CO1
1.2	Design principles of Cantilever sheet pile wall	2	
1.3	Anchored sheet pile wall	1	
1.4	Fixed earth support method for Anchored sheet pile wall	1	
1.5	Equivalent beam method	1	
2	**Raft Foundation**		
2.1	Types of Raft foundation	1	CO2
2.2	Allowable pressures for raft in cohesive and cohesionless soils	1	
2.3	Conventional design of raft foundation	2	
2.4	Flat slab raft foundation	1	
2.5	Beam and slab raft foundation	1	
3	**Pile Foundation**		
3.1	Structural design of Precast piles	2	
3.2	Cast in-situ piles	1	

3.3	Under reamed piles	1	CO3
3.4	Stone columns	1	
3.5	Batter piles for lateral loads – Culmann method – Graphical method	1	
3.6	IS 2911 method of lateral resistance of vertical piles – Broms chart	2	
4	**Pile Group**		
4.1	Pile Group: Pile spacing and efficiency of pile group	1	CO4
4.2	Load carrying capacity of pile groups	1	
4.3	Pile group subjected to eccentric vertical load	1	
4.4	Settlement of pile group	1	
4.5	Design of pile cap	2	
5	**Caisson Foundation**		
5.1	Introduction and types of caisson foundation	2	CO5
5.2	Estimation of load bearing capacity of caisson foundation in cohesionless soil and in cohesive soil	1	
5.3	Stability Analysis by limit equilibrium method	2	
6	**Braced cuts**		
6.1	Lateral earth pressure in braced cuts	2	CO6
6.2	Components of braced cuts	1	
6.3	Stability of braced cuts	2	
	Total Hours	**36**	

Course Designer(s):

1. Dr. R.SanjayKumar sanjaykumar@tce.edu

22CEQA0	BUILDING DESIGN

CATEGORY	L	T	P	CREDIT
PSE	3	0	0	3

Preamble

This course work imparts Primitive knowledge and principles required for designing the various components of building and its services with the help of relevant codes, manuals, guidelines and good practices.

Prerequisite

NIL

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency scale	Expected Proficiency scale	Expected Attainment level
CO1	Enumerate the processes involved in planning of Building construction	TPS2	A	75
CO2	Integrate the allied services involved in buildings	TPS3	A	75
CO3	Assess the factors that contribute to the human comfort in buildings.	TPS3	A	75
CO4	Identify the techniques and design options to achieve energy efficiency in buildings	TPS3	A	75
CO5	Integrate the sustainable concepts in building design strategies.	TPS3	A	75
CO6	Apply the practical aspects of sustainable design to enhance the functionality of a building.	TPS3	A	75

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

CO	CAT1			CAT2			Terminal			ASSIGNMENT I			ASSIGNMENT II		
TPS Scale	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	5	15	-	-	-	-	2	5	-	-	30	-	-	-	-
CO2	5	10	25	-	-	-	2	5	10	-	-	30	-	-	-
CO3	5	10	25	-	-	-	2	5	10	-	-	40	-	-	-
CO4	-	-	-	5	10	15	2	5	10	-	-	-	-	-	30
CO5	-	-	-	5	10	15	2	5	15	-	-	-	-	-	30
CO6	-	-	-	5	10	25	-	5	15	-	-	-	-	-	40

Syllabus

Site Analysis and Planning: Buildings-Classification and necessity of planning, Planning regulations and relevant codes, Building permit process-Building Bye laws, Components of a building, Types of Plans, Necessity of Integrated planning of various services in building, Elements of urban landscaping design, Ergonomics in design, Acoustics-Fundamentals, Concept and principles of Interior Design, Planning considerations for fire protection, fire fighting installations in buildings. **Climate and Built Environment:** Climate and human comfort, Design of solar shading devices, Design principles for Hot & Dry Climate, Air movement due to natural and built forms, principles of Ventilation, Necessity and Systems of Ventilation, Principles of Air Conditioning and Types. **Energy Efficient Design:** Energy Efficient Design and Processes-ECBC, Wiring systems and choices and energy ratings of appliances, Planning electrical wiring and Electrical layout for residential buildings, Lighting Design- Classification & Minimum level of illumination required for different types of building, Energy conservation in lighting - Energy efficient luminaries, Life Cycle Assessment and Embodied Energy. **Design Strategies:** Net zero Buildings, Climate Responsive Buildings, Cost Effective Constructions, Approaches and concepts of Vernacular Architecture, Green Buildings, building automation in Smart Buildings.– Human machine interface and intelligent systems. **Emerging trends and Practices:** Recent trends in Building design & Introduction to BIM, Decentralized waste management system –wastewater and solid waste, Water Conservation measures.-Grey water treatment systems, design of storm water drainage and rain water harvesting system, Principles of Water supply & Sanitation –Dual plumbing system, Nature based process for treatment of Wastewater.

Learning Resources

1. National Building Code of India -2016
2. Development Control Rules by Chennai Metropolitan Development Agency - 2006
3. Energy Conservation Building Code – 2007
4. CPHEEO Manual on Sewerage and sewage treatment systems – 2013
5. Manual for environmental clearance for large construction projects – by Ministry of environment, forest and climate change.
6. Energy-efficient buildings in India-Editor by Mili Majumdar, Ministry of Non-conventional Energy Sources.
7. Climate Responsive Architecture: A Design Handbook For Energy Efficient Buildings 1St Edition by Simos Yannas and Arvind Krishan and Steve Szokolay and Nick Baker, McGraw **Hill**

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	Course outcomes
1.0	**Site Analysis and Planning**		
1.1	Buildings-Classification and necessity of planning	1	CO1
1.2	Selection of site and space planning	1	
1.3	Planning regulations and relevant codes	1	
1.4	Building permit process-Building Bye laws	1	
1.5	Components of a building	1	

1.6	Types of Plans	1	
1.7	Necessity of Integrated planning of various services in building	1	CO2
1.8	Elements of urban landscaping design	1	
1.9	Ergonomics in design	1	
1.10	Acoustics-Fundamentals	1	
1.11	Concept and principles of Interior Design	1	
1.12	Planning considerations for fire protection, fire fighting installations in buildings.	1	
2.0	**Climate and Built Environment**		
2.1	Climate and human comfort	1	CO3
2.3	Design of solar shading devices	1	
2.4	Design principles for Hot & Dry Climate	1	
2.5	Air movement due to natural and built forms	1	
2.6	principles of Ventilation, Necessity and Systems of Ventilation	1	
2.7	Principles of Air Conditioning and Types.	1	
3.0	**Energy Efficient Design**		
3.1	Energy Efficient Design and Processes-ECBC	1	CO4
3.2	Wiring systems and choices and energy ratings of appliances	1	
3.3	Planning electrical wiring and Electrical layout for residential buildings	1	
3.4	Lighting Design- Classification & Minimum level of illumination required for different types of building	1	
3.5	Energy conservation in lighting - Energy efficient luminaries	1	
3.6	Life Cycle Assessment and Embodied Energy	1	
4.0	**Design Strategies**		
4.1	Net zero Buildings	1	CO5
4.2	Climate Responsive Buildings	1	
4.3	Cost Effective Constructions	1	
4.4	Approaches and concepts of Vernacular Architecture	1	
4.5	Green Buildings	1	
4.6	building automation in Smart Buildings.– Human machine interface and intelligent systems	1	
5.0	**Emerging trends and Practices**		
5.1	Recent trends in Building design & Introduction to BIM	1	CO6
5.2	Decentralized waste management system – wastewater and solid waste.	1	
5.3	Water Conservation measures. - Grey water treatment systems	1	
5.4	design of storm water drainage and rain water harvesting system	1	
5.5	Principles of Water supply & Sanitation –Dual plumbing system.	1	
5.6	Nature based process for treatment of Wastewater	1	
	TOTAL	**36**	

Course Designers:

1. Dr.V.RaviSankar environmentengr@tce.edu
2. Dr.G.Chitra gcciv@tce.edu

22CEQB0	SUSTAINABLE CONSTRUCTION AND BUILDING MATERIALS

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

This course presents a study of the concepts and techniques of sustainable construction. An in-depth review of sustainable materials and construction techniques will be covered.

Prerequisite

Basic Knowledge on building construction materials.

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Attainment level	Proficiency level
CO1	Examine the properties of common construction materials and understand the transition toward sustainable materials.	TPS3	B	65
CO2	Describe the materials used in construction	TPS3	B	65
CO3	Explain the method of estimating the amount of energy required for building.	TPS3	B	65
CO4	Explore the concept of thermal comfort and utility of solar energy in buildings.	TPS3	B	65
CO5	Describe Non-renewable sources of energy and Environmental aspects	TPS3	B	65
CO6	Understand the concepts of water and solid waste management.	TPS3	B	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern:

CO	CAT1			CAT2			Terminal			Assignment 1			Assignment 2		
TPS Scale	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	4	2	20	-	-	-	2	-	15	-	-	20	-	-	-
CO2	4	4	30	-	-	-	2	2	15	-	-	40	-	-	-
CO3	4	2	30	-	-	-	2	2	15	-	-	40	-	-	-
CO4	-	-	-	4	4	30	2	-	15	-	-	-	-		40
CO5	-	-	-	4	-	20	2	2	10	-	-	-	-	-	40
CO6	-	-	-	4	4	30	2	2	10	-	-	-	-	-	20

Syllabus:

Introduction and definition of Sustainability - Carbon cycle - role of construction material: concrete and steel, etc -Energy use, carbon emissions, water use, waste disposal; Building materials: sources, methods of production and environmental Implications. **Materials used in sustainable construction**-Framed Construction, Masonry Construction. Resources for Building Materials, Alternative concepts. Recycling of Industrial and Buildings Wastes. Biomass Resources for buildings. Construction materials and indoor air quality - No/Low cement concrete – Recycle- Life cycle and sustainability. **Energy calculations-**Components of embodied energy - calculation of embodied energy for construction materials - Energy concept and primary energy - Embodied energy via-a-vis operational energy in conditioned building - Life Cycle energy use. **Comfort in buildings-**Thermal Comfort in Buildings- Issues; Heat Transfer Characteristic of Building Materials and Building Techniques. Incidence of Solar Heat on Buildings-Implications of Geographical Locations. Utility of Solar energy in buildings. Concepts of Solar Passive Cooling and Heating of Buildings. Low Energy Cooling. Case studies of Solar Passive Cooled and Heated Buildings. **Environmental effects-** Non-renewable sources of energy and Environmental aspects – energy norm, coal, oil, natural gas - Nuclear energy - Global temperature, Green house effects, global warming - Acid rain: Causes, effects and control methods. **Water & solid waste management-** Concepts of Green Composites. Water Utilisation in Buildings, Low Energy Approaches to Water Management. Management of Solid Wastes. Management of Sullage Water and Sewage. Urban Environment and Green Buildings. Green Cover and Built Environment.

Learning Resources:

1. Charles J Kibert, Sustainable Construction: Green Building Design & Delivery, 4th Edition Wiley Publishers 2016.
2. Steve Goodhew, Sustainable Construction Process, Wiley Blackwell,UK, 2016.
3. Craig A. Langston & Grace K.C. Ding, Sustainable Practices in the Built Environment, Butterworth Heinemann Publishers, 2011.
4. William P Spence, Construction Materials, Methods & Techniques (3e), Yesdee Publication Pvt. Ltd, 2012.
5. Rebecca L. Henn; Andrew J. Hoffman (2013), Constructing Green the Social Structures of Sustainability (Urban and Industrial Environments), MIT Press.
6. Steve Goodhew Sustainable Construction Processes: A Resource Text ISBN: 978-1-40518759-6 May 2016 Wiley-Blackwell.
7. S.B.Marinkovic, Life cycle assessment (LCA) aspects of concrete, Woodhead Publishing Series in Civil and Structural Engineering 2013, Pages 45-80.

Course Contents and Lecture Schedule:

Module No.	Topic	No. of Lectures	Course Outcome
1.0	**Introduction to sustainability:**		
1.1	Définition - Carbon cycle - Energy use, Carbon émissions	2	CO1
1.2	Role of construction material: concrete and steel, etc	1	
1.3	CO2 contribution from cement and other construction materials	1	
1.4	Building materials: sources and methods of production and environmental Implications	2	
2.0	**Materials used in sustainable construction:**		
2.1	Framed Construction, Masonry Construction.	2	CO2
2.2	Resources for Building Materials, Alternative concepts.	1	
2.3	Recycling of Industrial and Buildings Wastes	1	
2.4	Biomass Resources for buildings	1	
2.5	Recycle- Life cycle and sustainability	1	
3.0	**Energy calculations:**		
3.1	Components of embodied energy	1	
3.2	Calculation of embodied energy for construction materials	1	

3.3	Energy concept and primary energy	1	CO3
3.4	Components of Embodied energy - operational energy in conditioned building Life Cycle energy use	2	
4.0	**Comfort in buildings:**		
4.1	Thermal Comfort in Buildings- Issues; Heat Transfer Characteristic of Building Materials and Building Techniques.	2	CO4
4.2	Incidence of Solar Heat on Buildings - Implications of Geographical Locations.	1	
4.3	Utility of Solar energy in buildings. Concepts of Solar Passive Cooling and Heating of Buildings. Low Energy Cooling.	2	
4.4	Case studies of Solar Passive Cooled and Heated Buildings.	1	
5.0	**Environmental effects:**		
5.1	Non-renewable sources of energy and Environmental aspects	2	CO5
5.2	Energy norm, coal, oil, natural gas - nuclear energy	1	
5.3	Global temperature, green house effects, global warming -	1	
5.4	Acid rain: Causes, effects and control methods	2	
6.0	**Water & solid waste management:**		
6.1	Concepts of Green Composites. Water Utilisation in Buildings	2	CO6
6.2	Low Energy Approaches to Water Management.	1	
6.3	Management of Solid Wastes	1	
6.4	Management of Sullage Water and Sewage.	1	
6.5	Urban Environment and Green Buildings.	1	
6.6	Green Cover and Built Environment	1	
	Total Hours	**36 Hrs**	

Course Designers:

1. Dr. D.Brindha dbciv@tce.edu

22CEQC0	URBAN PLANNING AND DEVELOPMENT

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

Urban planning and design must seek to improve the quality of the life of people living in complex urban conditions, with full respect for indigenous, cultural and social needs. This course is intended to raise the awareness of the components of physical city and the forces that shape it and the planning of urban infrastructure in the urban context

Prerequisite

Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency	Attainment level %
CO1	Understand the characteristics and types of urban settlements	TPS2	B	65
CO2	Identify the role of urban planning in development	TPS2	B	65
CO3	Understand the theories and models of urbanplanning	TPS2	B	65
CO4	Understand the urban guidelines for development and planning	TPS3	B	65
CO5	Design infrastructure with an understanding of the urban context and sustainable development	TPS3	B	65
CO6	Understand the urban development with example	TPS3	B	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern:

CO	CAT1			CAT2			Terminal			Assignment 1			Assignment 2		
TPS Scale	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	10	20	-	-	-	-	4	10	-	-	20	-	-	-	-
CO2	10	30	-	-	-	-	4	15	-	-	40	-	-	-	-
CO3	10	20	-	-	-	-	4	15	-	-	40	-	-	-	-
CO4	-	-	-	10	30	30	4	15	-	-	-	-	-	40	-
CO5	-	-	-	8	20		4	10	-	-	-	-	-	20	-
CO6	-	-	-	-	-	30	-	-	15	-	-	-	-	-	40

Syllabus

Introduction to Urban settlements: Definition of settlements, rural and urban settlements – their characteristics ; Basic components, factors influencing urban settlements and their interrelationships; Anatomy & classification of Human settlements based on configuration of shape, function, location, Resource, Population & Occupational structure; Structure and form of Human settlements – Linear, non-linear and circular –Combinations; Structure and form of Human settlements – Linear, non-linear and circular –Combinations; Reasons for development – Major Growth factors – advantages and disadvantages – case studies – factors influencing development / decay. **Urban Planning;** Need, General issues and potentials of urban planning; Planning process and monitoring; Planning machinery in India- levels of planning – Town and country planning act; Types of development plans - Regional plan, Master plan, Structure plan, Zonal Development plan – their scope and content; Urban Development programmes like JNNURM, TNUDP, IDSMT etc; **Infrastructure planning for urban development;** Theories of urban development ; Land Use models ; Introduction to modes of planning; Various urban development strategies and initiatives in India; smart city – smart grid; **Guidelines for Urban Development and Infrastructures;** National and international guidelines; planning norms and standards for zoning and sub division, physical (transport, water supply, drainage, solid waste management, power etc), social (educational, health, recreational, cultural etc) infrastructure, residential and commercial infrastructure. **Sustainable urban development;** Ecological- Indicators of ecological analysis - environmental and social impact of urbanization and development; Policies and urban design guidelines for new developments; **Impact of Urbanization;** Regulations and legislation w.r.t environment; Environmental Impact assessment – need, process and issues; social and environmental cost benefit; **Case Studies:** Best practices in urban planning and design – inter-national and national case studies; Case studies of Planning of large scale residential, commercial, physical and social Infrastructure at urban level.

Learning Resources

1. Arthur B Gallion "The urban pattern", CBS publishers, 1983
2. Frederic J. OSBORN -New towns - Arnold whittick – Leonard Hill, 1988
3. Gideon golany "Urban Planning for Arid Zones" , A wiley interscience publicationMTP construction, 1995
4. Kevin Lynch," Image of the city" - MIT Press, 1992
5. Koperdekar H.D & Diwan G.R. " Urban and Regional Planning: Principles", practiceand law, 1994
6. Pratap Rao M. "Urban Planning theory and practice", cbs, http: www.bagchee.com/books

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	Course Outcome
1.0	**Introduction to Urban settlements**		
1.1	Definition of settlements, rural and urban settlements – their characteristics; Basic components, factors influencing urban settlements and their interrelationships	2	CO1
1.2	Anatomy and classification of Human settlements based on configuration of shape, function, location, Resource, Population & Occupational structure	2	
1.3	Structure and form of Human settlements – Linear, non-linear and circular –Combinations	1	
1.4	Reasons for development – Major Growth factors – advantages and disadvantages – case studies – factor influencingdevelopment / decay	2	
2.0	**Urban Planning**		
2.1	Need, General issues and potentials of urban planning; Planning process and monitoring	2	CO2

2.2	Planning machinery in India – levels of planning – Town and country planning act.	2	
2.3	Types of development plans - Regional plan, Master plan, Structure plan, Zonal Development plan – their scope and content;	2	
2.4	Urban Development programmes like JNNURM, TNUDP, IDSMT etc	1	
3.0	**Urban development**		
3.1	Introduction to modes of planning	1	CO3
	Theories of urban development;	2	
	Land Use models	1	
3.2	Various urban development strategies and initiatives in India,	1	
3.3	Smartcity – overview	1	
4.0	**Guidelines for Urban Development and Infrastructures**		
4.1	National and International guidelines; planning norms and standards for zoning and sub division	2	CO4
4.2	Physical Infrastructure - Transportation, waste management and drainage	1	
4.3	Social Infrastructure - educational, health, recreational, cultural etc	1	
4.4	Residential and commercial infrastructure	1	
5.0	**Impact of urbanization**		
5.1	Indicators of ecological analysis and impact of urbanization anddevelopment	1	CO5
5.2	Environmental impact of urbanization anddevelopment	1	
5.3	Social impact of urbanization anddevelopment	1	
5.4	Environmental Impact assessment – need , process and issues ; social and environmental cost benefit;	2	
6.0	**Case Studies**		
6.1	Best practices in urban planning and design – inter-national case studies	2	CO6
6.2	Best practices in urban planning and design – national case studies	2	
6.3	Case studies of Planning of large scale residential Infrastructure at urban level	1	
6.4	Case studies of Planning of large scale commercial Infrastructure at urban level	1	
	Total Hours	**36**	

Course Designers:

1. Dr. R. Velkennedy rvkciv@tce.edu
2. Dr.K.Athiappan kanciv@tce.edu

22CEQD0	GREEN AND SUSTAINABLE BUILDING

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

To impart knowledge on sustainable construction and to understand the concepts of sustainable and green buildings and environmental effects.

Prerequisite

Nil

Course Outcomes

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

COs	Course Outcome Statements	TCE Proficiency Scale	Expected Proficiency	Expected Attainment Level %
CO1	Explain various sustainable materials used in construction with purpose	TPS2	A	75
CO2	Calculate the embodied and operational energy of building by various methods	TPS 3	B	65
CO3	Control energy consumption in building knowing the features of GRIHA rating of buildings	TPS 3	A	75
CO4	Rate buildings based on features of LEED, TERI standards	TPS 3	B	65
CO5	Apply the concept and study the performance of zero energy buildings	TPS 3	B	65
CO6	Choose appropriate construction materials for various applications with less carbon emissions and environmental impacts	TPS 3	B	65

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

S-Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
CO1	10	5	-	-	-	-	-	-	-	-	-	-	2	10	-	-	-	-	-	-	20		-	-	-	-	-	-	-	-
CO2	5	10	30	-	-	-	-	-	-	-	-	-	2	-	15	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO3	5	5	30	-	-	-	-	-	-	-	-	-	2	10	10	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	10	20	-	-	-	-	10	10	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-
CO5	-	-	-	-	-	-	5	5	20	-	-	-	2	-	15	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-
CO6	-	-	-	-	-	-	10	5	20	-	-	-	2	-	10	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-

Syllabus

Introduction: Introduction and definition of Sustainability - Carbon cycle - role of constructionmaterial: concrete and steel, etc. CO_2 contribution from cement and other construction materials. **Materials used in sustainable construction:** Construction materials and indoor air quality -No/Low cement concrete - Recycled and manufactured aggregate - Role of QC and durability -Life cycle and sustainability. **Energy calculations:** Components of embodied energy–basic calculation of embodied energy for construction materials - Energy concept and primary energy - Embodied energy and operational energy in conditioned building - Life Cycle energy use of buildings. **Green buildings:** Control of energy use in building - ECBC code, codes in neighboring tropical countries — Features of LEED and TERI — GRIHA ratings - Role of insulation and thermal properties of construction materials -Performance ratings of green buildings -Zero energy building. **Environmental effects:** Non-renewable sources of energy and Environmental aspects – energy norms - coal, oil, natural gas - Nuclear energy-Green house effects, global warming.

References

1. Charles JKibert, Sustainable Construction: Green Building Design & Delivery, 4th Edition, Wiley Publishers2016.
2. Steve Goodhew, Sustainable Construction Process, Wiley Blackwell, UK,2016.
3. CraigA. Langston & Grace K.C.Ding, SustainablePracticesintheBuiltEnvironment,ButterworthHeinemannPublishers,2011.
4. WilliamPSpence, Construction Materials, Methods & Techniques (3e), Yesdee Publication Pvt.Ltd, 2012.
5. New Building Materials and Construction World magazine.

Course Contents and Lecture Schedule

Module No	Topics	No. of Lectures	COs
1.0	**Introduction**		
1.1	Introduction and definition of Sustainability	1	
1.2	Carbon cycle		
1.3	Role of construction material: concrete and steel, etc.	2	
1.4	CO_2 contribution from cement and other construction materials	2	
2.0	**Materials used in sustainable construction**		**CO1**
2.1	Construction materials and indoor air quality	1	
2.2	No / Low cement concrete	1	
2.3	Recycled and manufactured aggregate		
2.4	Role of QC and durability	2	
2.5	Life cycle and sustainability	2	
3.0	**Energy calculations**		
3.1	Components of embodied energy	2	
3.2	Basic calculation of embodied energy for construction materials	2	
3.3	Energy concept and primary energy	1	**CO2**
3.4	Embodied energy and operational energy in conditioned building	2	
3.5	Life Cycle energy use of buildings	2	
4.0	**Green buildings**		
4.1	Control of energy use in building - ECBC code, codes in neighbouring tropical countries	2	
4.2	Features of GRIHA ratings – Control on energy consumption of buildings	2	**CO3**
4.3	Features of LEED and TERI rating in buildings	2	**CO4**
4.4	Performance ratings of green buildings	2	

5.0	**Zero Energy Buildings**		
5.1	Zero energy building - concept	2	**CO5**
5.2	Performance study of zero energy buildings	2	
6.0	**Environmental effects**		
6.1	Non - renewable sources of energy and Environmental aspects — energy norm -coal, oil, natural gas	2	**CO6**
6.2	Nuclear energy - Global temperature	1	
6.3	Green house effects, Global warming - environmental effects on buildings	1	
	Total hours	**36**	

Course Designers

Dr.G.Chitra gcciv@tce.edu
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22CEQE0	BUILDING MATERIALS AND CONSTRUCTION TECHNIQUES

Category	L	T	P	Credit
PSE	3	0	0	3

Preamble

This theory 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 with ventilation as per NBC provisions. This course also

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency in Grade	Expected Attainment Level in %
CO1	Apply NBC provisions and plan components of residential buildings along with ventilation aspects	TPS3	B	65
CO2	Explain the properties and uses of various natural and Man-made building materials	TPS3	B	65
CO3	Identify and describe the salient features various building components and supporting systems	TPS3	B	65
CO4	Know the different construction techniques and structural systems	TPS3	B	65
CO5	Understand various techniques and practices on masonry construction, flooring, and roofing	TPS3	B	65
CO6	To choose, maintain and operate hand and power tools and equipment used in the building construction sites.	TPS3	B	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	10	20	-	-	-	-	-	-	-	-	-	2	10	10	-	-	-	-	-	40	-	-	-	-	-	-	-	-	-
CO2	5	5	20	-	-	-	-	-	-	-	-	-	2	5	10	-	-	-		-	40	-	-	-	-	-	-	-	-	-
CO3	10	5	20	-	-	-	-	-	-	-	-	-	2	-	10	-	-	-		-	20	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	10	20	-	-	-	-	10	10	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-
CO5	-	-	-	-	-	-	5	5	20	-	-	-	2	-	15	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-
CO6	-	-	-	-	-	-	10	5	20	-	-	-	2	-	10	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-

Syllabus

Classification 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 ventilation aspects in buildings. NBC provisions for fire safety in buildings. **Materials for Construction**: Natural materials - stones, aggregates, timber, lime. Man- made materials: bricks, cement, steel, concrete, plastics, fly ash, 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 Techniques**: Structural systems - Load Bearing Structure - Framed Structure - Load transfer mechanism – floor system - Development of construction techniques - High rise Building Technology - Seismic effect - Environmental impact of materials. **Construction Practices**: Specifications, details and sequence of activities and construction co-ordination – Site Clearance – Marking – Earthwork - construction joints – movement and expansion joints **Construction Equipment**: Selection of equipment for earth work - earth moving operations - types of earthwork equipment - tractors, motor graders, scrapers, front end waders, earth movers – Equipment for foundation and pile driving. Equipment for compaction, batching, mixing and concreting - Equipment for material handling and erection of structures – types of cranes - Equipment for dredging, trenching, tunnelling.

Learning Resources

1. Bindra and Arora, Building Materials and Construction, Dhanpat Rai & Sons, New Delhi,1998
2. Surendra Singh, Building Materials, Vikas Publishing Company, NewDelhi,1996
3. Peurifoy, R.L., Ledbetter, W.B. and Schexnayder, C., "Construction Planning, Equipment and Methods", 5th Edition, McGraw Hill, Singapore, 1995.
4. Arora S.P. and Bindra S.P., "Building Construction, Planning Techniques and Method of Construction", Dhanpat Rai and Sons, 1997.
5. Varghese, P.C. "Building construction", Prentice Hall of India Pvt. Ltd, New Delhi, 2007.
6. National Building Code of India, Bureau ofIndianStandards,2016
7. Jha J and Sinha S.K., "Construction and Foundation Engineering", Khanna Publishers,1999.
8. Sharma S.C. “Construction Equipment and Management”, Khanna Publishers New Delhi, 2002.
9. Deodhar, S.V. “Construction Equipment and Job Planning”, Khanna Publishers, New Delhi, 2012.
10. Mahesh Varma, “Construction Equipment and its Planning and Application”, Metropolitan Book Company, New Delhi, 1983.
11. NPTEL- Building Materials and Construction - https://nptel.ac.in/courses/105102088

Course Contents and Lecture Schedule

Module No	Topics	No. of Lectures	COs
1.0	Classification of Buildings		CO1
1.1	Classification of Buildings as per NBC	1	
1.2	Site selection and its influencing factor	1	
1.3	National Building Codal provisions for components of residential buildings: Open spaces, Living room, Bedroom, Kitchen, Bathroom and Water closet	2	
1.4	Building Ventilation aspects	1	
2.0	Materials for Construction		**CO2**

2.1	Natural materials - Stones, timber, lime, aggregates – Properties and uses	2	
2.2	Man made materials- Bricks, cement, concrete, steel, plastics, fly ash, GGBS, silica fume, PCC and RCC,	2	
3.0	Components of building & Technologies for Construction		CO3
3.1	Components of Building	1	
3.2	Stone Masonry	1	
3.3	Brick Masonry	2	
3.4	Damp Proof Course	1	
3.5	Lintels	1	
3.6	Arches	1	
3.7	Flooring	1	
3.8	Roofing	1	
3.9	Stairs	1	
3.10	Scaffolding	1	
3.11	Pointing Plastering and Painting	1	
3.12	Shoring and Underpinning	1	
4.0	**Construction techniques**		
4.1	Structural systems - Load Bearing Structure - Framed Structure	1	CO4
4.2	Load transfer mechanism – floor system	1	
4.3	Development of construction techniques - High rise Building Technology - Seismic effect - Environmental impact of materials	2	
5.0	**Construction Practices**		
4.1	Specifications, details and sequence of activities and construction co-ordination	1	CO5
4.2	Site Clearance – Marking – Earthwork -	1	
4.3	Concrete hollow block masonry – flooring	1	
4.4	Construction joints – movement and expansion joints	1	
6.0	**Construction equipment**		
6.1	Selection of equipment for earth work - earth moving operations - types of earthwork equipment - tractors, motor graders, scrapers, front end waders, earth movers	2	CO6
6.2	Equipment for foundation and pile driving	1	
6.3	Equipment for compaction, batching, mixing and concreting	1	
6.4	Equipment for material handling and erection of structures – types of cranes - Equipment for dredging, trenching, tunneling	2	
	Total Hours	**36**	

Course Designers:

1. Ms. M. Aruna maciv@tce.edu
2. Dr. D. Rajkumar rajkumarcivil@tce.edu
3. Dr. A. Rajasekar rajasekara@tce.edu

22CEQF0	BUILDING ESTIMATION AND VALUATION

Category	L	T	P	Credit
PSE	2	1	0	3

Preamble

Lean Construction is an essential shift from conventional construction management. Lean approach seeks to improve project delivery by minimizing waste and maximizing value to the customer. This course has been intended to impart the key concepts, tools, and practices to improve the construction processes.

Prerequisite

Nil

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency in Grade	Expected Attainment Level in %
CO1	Draw the section through a wall and explain the various components of a building with purpose.	TPS 2	A	75
CO2	Estimate quantities of items of works-Foundation, Plinth, DPC, Floor components, steps for residential buildings of load bearing wall -Centre line method knowing the units of measurement of works	TPS 3	A	75
CO3	Estimate quantities of items of works-Superstructure wall, Roof with weathering course, Plastering, painting, parapet for residential buildings of load bearing wall -Centre line method knowing the units of measurement of works	TPS 3	A	75
CO4	Estimate quantities of items of works for residential buildings of framed type – Centre line method	TPS 3	A	75
CO5	Explain the need and various terms in connection with valuation of buildings	TPS 2	B	65
CO6	Value buildings based on different methods	TPS 3	B	65

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

CO	CAT1						CAT2						Terminal						Assignment 1						Assignment 2					
TPS Scale	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	15	-	-	-	-	-	-	-	-	-	-	2	10	-	-	-	-	-	-	30		-	-	-	-	-	-	-	-
CO2	5	10	30	-	-	-	-	-	-	-	-	-	2	-	20	-	-	-	-	-	30		-	-	-	-	-	-	-	-
CO3	5	-	30	-	-	-	-	-	-	-	-	-	2	-	20	-	-	-	-	-	40		-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	5	5	30	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-
CO5	-	-	-	-	-	-	5	10	-	-	-	-	2	10	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-
CO6	-	-	-	-	-	-	5	10	30	-	-	-	2	-	15	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-

Syllabus

Components of a building: Section through a wall - components of a building with purposes, Estimate- definition, need. **Units of Measurement of works**. Preparation of Preliminary estimate of buildings of buildings – plinth area rate method, cubic content method. **Detailed Estimate of building:** Individual wall method- brief concept. Estimate quantities of items of works for residential buildings (Excavation for foundation, PCC, Footings, Plinth, DPC, Floor components, Superstructure walls with appropriate deductions, roof, weathering course, plastering, parapet, steps at plinth level etc) of load bearing type using Centre line method. **Estimate of Buildings with framed structure and sloped roof. Valuation of buildings- Concept:** Meaning and need for valuation, Terms in connection with valuation of buildings- Methods of valuation of buildings, criteria for valuing a building. **Valuation of buildings- procedure and problems:** Valuing a building based on methods such as rental method, direct comparisons of capital value, profit, cost, depreciation method and development method.

References

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
3. Robert Peurifoy and Gerold Oberlender "Estimating Construction Costs", Kindle Edi, 2011
4. Govt of Tamil Nadu PWD – "Standard Schedule of Rates", latest
5. CPWD –DSR: https://cpwd.gov.in › Publication › DSR_Vol_2_2018
6. https://www.coursera.org/learn/construction-cost-estimating

Course Contents and Lecture Schedule

Module No	Topics	No. of Lectures	Cos
1.0	**Components of a building:**		
1.1	Section through a wall - components of a building with purposes	2	CO1
1.2	Units of measurements of works	1	
1.3	Estimate- definition, need. Preparation of Preliminary estimate of buildings of buildings – plinth area rate method, cubic content method	1	
1.4	Tutorials in preliminary estimates	2	
2.0	**Detailed Estimate of building by Centre line method**		
2.1	Individual Wall method – brief concept	1	CO2

2.2	Estimate quantities of items of works- excavation for foundation, PCC, footings for residential buildings of load bearing type using Centre Line method	2	
2.3	Estimate quantities of items of works – Plinth, DPC, Floor components and steps for residential buildings of load bearing type using Centre Line method	2	
2.4	Tutorial	2	
3.0	**Detailed Estimate of building by Centre line method**		
3.1	Estimate quantities of items of works- Superstructure wall with appropriate deductions, Roof with weathering course, lintel cum sunshade for residential buildings of load bearing type using Centre Line method	2	CO3
3.2	Estimate quantities of items of works- Plastering (Interior and Exterior), Painting, Parapet wall for residential buildings of load bearing type using Centre Line method	1	
3.3	Tutorial	2	
4.0	**Estimate of Buildings with framed structure and sloped roof**		
4.1	Estimate quantities of items of works for residential buildings of framed type	2	CO4
4.2	Estimate quantities of items of works for residential buildings of framed type, differential foundation and sloped roof	1	
4.3	Tutorial	2	
5.0	**Valuation of buildings- Concept**		
5.1	Meaning and need for valuation, Terms in connection with valuation of buildings	1	CO5
5.2	Methods of valuation of buildings, criteria for valuing a building	2	
5.3	Tutorial	2	
6.0	**Valuation of buildings- procedure and problems**		CO6
6.1	Value a building based on rental method	1	
6.2	Value a building based on direct comparisons of capital value	1	
6.3	Value a building based on profit	1	
6.4	Value a building based on cost	1	
6.5	Value of building based on depreciation method	1	
6.6	Value a building based on development method	1	
6.7	Tutorial	2	
	Total	**36**	

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Department of Civil Engineering-List of Courses
B.E./B.Tech. (HONOURS AND MINORS)

HONOURS					MINOR
VERTICAL I CONSTRUCTION TECHNOLOGY AND MANAGEMENT	*VERTICAL II* GEOTECHNICAL AND TRANSPORTATION ENGINEERING	*VERTICAL III* ENVIRONMENTAL ENGINEERING	*VERTICAL IV* STRUCTURURAL ENGINEERING	*VERTICAL V* WATER RESOURCES	*VERTICAL* ECOFRIENDLY CONSTRUCTION
22CERR0 Construction Equipment Management	22CEPW0 Airways and Waterways	22CEPM0 Municipal Solid Waste Management	22CEPB0 Dynamics of Structures and Earthquake Engineering	22CEPT0 Engineering Hydrology	22CEQA0 Building Design
22CERS0 Quantitative Methods in Management	22CERX0 Traffic Engineering and Management	22CEPN0 Air and Noise Pollution Management	22CERG0 Design of Steel-Concrete Composite Structures	22CEPS0 Groundwater Management	22CEQB0 Sustainable Building Materials
22CERT0 Contracts and Arbitration	22CERY0 Pavement Analysis and Design	22CERK0 Industrial wastewater Management	22CEPJ0 Advanced Reinforced Concrete Design	22CERL0 Sustainable Management of Urban Ecology	22CEQC0 Urban Planning and Development
22CERU0 Lean Construction	22CEPX0 Geotechniques for Infrastructure	22CEPQ0 Environmental Impact Assessment	22CEPD0 Bridge Engineering	22CERN0 Environmental Remote Sensing	22CEQD0 Green and Sustainable Building
22CERV0 Material Procurement and Management	22CEPU0 Ground Improvement Techniques	22CERJ0 Resource and Energy Recovery from Wastes	22CERH0 Cold Formed Steel Structural Design	22CERP0 Surface and Ground Water Quality Modeling	22CEQE0 Building Materials and Techniques
22CERW0 Management of Human Resource, Safety and Quality	22CERZ0 Design of Foundation and Substructure	22CERM0 Environmental Policies and Legislation	22CEPL0 Structural Masonry	22CERQ0 Computational Intelligence for Hydrosystems	22CEQF0 Building Estimation and Valuation

21CE661	DESIGN OF REINFORCED CONCRETE ELEMENTS

Category	L	T	P	Credit
PC	3	0	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.

Prerequisites

21CE220 Engineering Mechanics and 21CE510 Concrete Technology

Course Outcomes

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

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Explain the design concepts of structural reinforced concrete elements under various forces and interpret IS codal provisions and design the elements under flexure by working stress design method	10
CO2	Design the structural reinforced concrete elements under flexure by limit state design method and detail the reinforcement	25
CO3	Design the structural reinforced concrete elements under shear, torsion, anchorage and development length by limit state design method and detail the reinforcement	15
CO4	Design the structural reinforced concrete elements under compression by limit state design method and detail the reinforcement	20
CO5	Check the serviceability requirements of reinforced concrete elements under deflection and cracking	10
CO6	Design the foundation by limit state design method and detail the reinforcement	20

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS2	Understand	Respond	Guided Response	1.1.1, 2.1.1
CO2	TPS3	Apply	Value	Mechanism	1.1.1,1.2, 1.3, 2.1.4, 2.1.5, 3.2.3
CO3	TPS3	Apply	Value	Mechanism	1.1.1, 1.2,1.3, 2.1.4
CO4	TPS3	Apply	Value	Mechanism	1.1.1,1.2, 1.3, 2.1.4, 2.1.5, 3.2.3
CO5	TPS2	Understand	Respond	Guided Response	1.1.1, 2.1.1
CO6	TPS3	Apply	Value	Mechanism	1.1.1, 1.2, 1.3, 2.1.5, 2.4.4.

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	10	10	-	-	10
Understand	10	10	-	-	10
Apply	80	80	100	100	80
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Assignment
Perception	-
Set	-
Guided Response	50
Mechanism	50
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

Course Outcome 1 (CO1):

1. Define the term characteristic strength of materials.
2. Explain the differences between working stress method and limit state method.
3. Explain the stress-strain behavior of steel and find the stress and strain at various stress levels for Fe415 and Fe500 grade steels.
4. Compute the reinforcement by working stress method required for the rectangular section of size 230mm x 500mm effective subjected to a moment of 150 kNm. The materials used in the design are M20 and Fe415. Draw the cross section and longitudinal section of the beam showing reinforcement details.

Course Outcome 2 (CO2):

1. What is the minimum reinforcement requirement for beam as per IS 456:2000

2. 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.
3. 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.

Course Outcome 3 (CO3):

1. What are the IS codal provisions related to design of beam subjected to combined bending, shear and torsion?
2. 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.
3. Compute the reinforcement required for a rectangular beam circular in plan 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.

Course Outcome 4 (CO4):

1. What is the reason for limiting maximum of 4% reinforcement in columns?
2. 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.
3. 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.

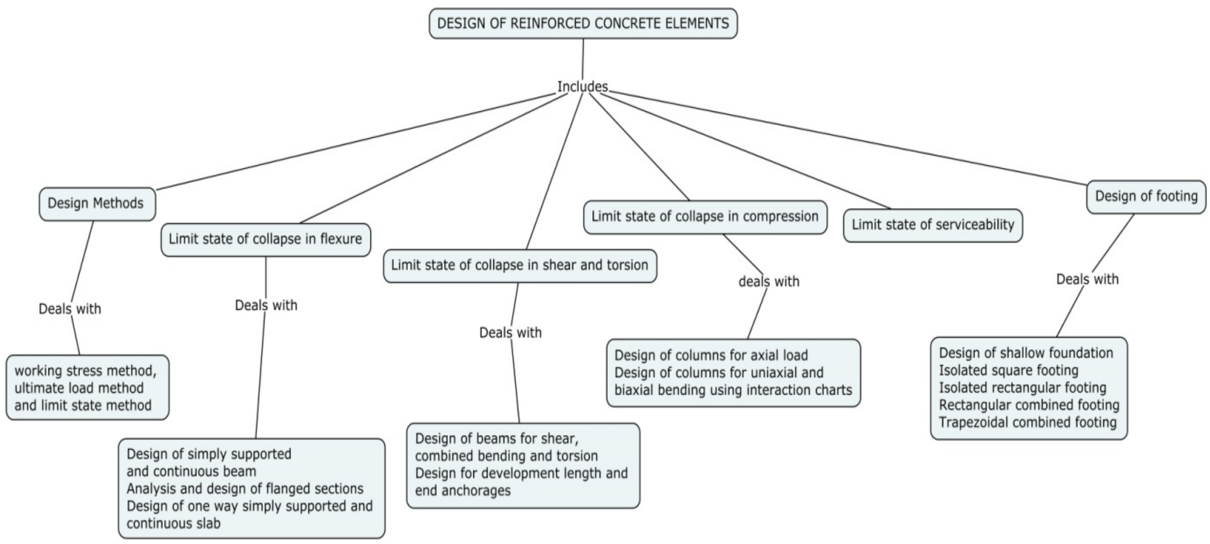
Course Outcome 5 (CO5):

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.

Course Outcome 6 (CO6):

1. What is the IS codal provision for nominal reinforcement required for footing?
2. Compute 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.
3. 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.

Concept Map



Syllabus

Design Methods: concept of working stress method, ultimate load method and limit state method. Advantages of limit state method over other methods. 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. Design of beams and slabs by working stress method; Development of spreadsheets; Reinforcement detailing. **Limit state of collapse for 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 and flanges sections - simply supported and continuous beams; Design of one way and two way slabs – simply supported, continuous and restrained using coefficients in IS code; Development of spreadsheets; Reinforcement detailing. **Limit state of collapse for bond, anchorage, shear and torsion**: Design of beams for shear and torsion; Design of beams for combined bending, shear and torsion; Design for development length and end anchorages; Reinforcement detailing. **Limit state of collapse for compression**: Braced and unbraced columns; Design of columns for axial load – square, rectangular and circular cross sections with lateral and spiral ties; Design of columns for uniaxial and biaxial eccentricities using interaction charts; Reinforcement detailing. **Limit state of serviceability**: Serviceability requirements for RC elements; 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; Development of spreadsheets; Reinforcement detailing.

Learning Resources

1. N. Subramanian, Design of Reinforced Concrete Structures, Oxford University Press, New Delhi, 2014.
2. UnnikrishnaPillai and DevdasMenon, Reinforced Concrete Design (Fourth Edition), Tata McGraw Hill Publishing Company Ltd., New Delhi, 2021.
3. P.C. Varghese, Limit State Design of Reinforced Concrete, Prentice Hall of India, Pvt. Ltd., New Delhi, 2008.
4. M.L. Gambhir, Fundamentals of Reinforced Concrete Design, Prentice Hall of India Private Limited, New Delhi, 2006.
5. N. Krishna Raju and R.N. Pranesh, Reinforced Concrete Design IS 456-2000, Principles and practice, New Age International (P) Ltd Publishers, New Delhi, 2018.

6. S.N. Sinha, Reinforced Concrete Design, Tata McGraw-Hill, New Delhi, 2017.
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(1-2):1987 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures.
3. IS 875(3):2015 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures
4. IS 875(4-5):1987 Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures
5. SP 16:1980 Design Aids for Reinforced Concrete to IS 456:1978.
6. SP 34:1987 Handbook of concrete reinforcement and detailing.
7. Handbook for Limit State Design of Reinforced Concrete Structures – Roorkee.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures	Course Outcome
1.0	**Design Methods**		
1.1	Concept of working stress method, ultimate load method and limit state method, advantages of Limit State Method over other methods 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	1	CO1
1.2	Analysis and design of beams by working stress method	2	CO1
1.3	Design of slabs by working stress method and developing spreadsheets	1	CO1
1.4	Reinforcement detailing	1	CO1
2.0	**Limit state of collapse for flexure**		
2.1	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	1	CO2
2.2	Analysis and design of singly reinforced rectangular sections and developing spreadsheets	1	CO2
2.3	Analysis and design of doubly reinforced rectangular sections	1	CO2
2.4	Design continuous beams using IS code coefficients	1	CO2
2.5	Analysis of flanged sections	2	CO2

2.6	Design of one way simply supported and continuous slab and developing spreadsheets	1	CO2
2.7	Design of two way simply supported, continuous and restrained slab using coefficients in IS code	2	CO2
2.8	Reinforcement detailing	1	CO2
3. 0	**Limit state of collapse for bond, anchorage, shear and torsion**		
3.1	Design of beams for shear and torsion	1	CO3
3.2	Design of beams for combined bending, shear and torsion	2	CO3
3.3	Design for development length and end anchorages	1	CO3
3.4	Reinforcement detailing	1	CO3
4.0	**Limit state of collapse in compression**		
4.1	Design of columns for axial load – square, rectangular and circular cross sections with lateral	1	CO4
4.2	Design of columns for axial load –circular cross sections with spiral ties	1	CO4
4.3	Design of columns for uniaxial bending using interaction charts	2	CO4
4.4	Design of columns for biaxial bending using interaction charts	2	CO4
4.5	Reinforcement detailing	1	CO4
5. 0	**Limit state of serviceability**		
5.1	Deflection calculations using IS code coefficients – short term and long term deflection	2	CO5
5.2	Crack width calculations	1	CO5
6. 0	**Design of shallow foundation**		
6.1	Design of isolated square footing and developing spreadsheets	1	CO6
6.2	Design of isolated rectangular footing and developing spreadsheets	1	CO6
6.3	Design of Rectangular combined footing and reinforcement detailing	2	CO6
6.4	Design of Trapezoidal combined footing and reinforcement detailing	2	CO6
	TOTAL	**36**	

Course Designers:

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21CERN1	DESIGN OF STEEL STRUCTURES

Category	L	T	P	Credit
PE	3	0	0	3

Preamble

This course offers the design of steel structures as per the limit state method. This course follows the recommendation of IS: 800 – 2007. It aim sat determination of safe as well as economical steel components such as plate girders, gantry girders , and beam-columns. This course also expose the student to IS: 875 provisions for various load calculations. The design of roof truss using rolled and tubusectionstion using IS: 800-2007 is covered in this course. Framed connections such as beam to beam, beam to column connection are also dealt in this course.

Prerequisite

18CE220-Engineering Mechanics, 18CE320-Mechnics of Solids, 18CE530-Design of Steel Structures

Course Outcomes

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

CO Number	Course Outcome Statement	Weightage*** in %
CO1	Design a Plate girder for its moment & shear and check the adequacy of the end panel using the IS800-2007 Provisions.	**20**
CO2	Design of Longitudinal and transverse Stiffeners for the Plate girder.	**15**
CO3	Analyze and design a gantry girder for its maximum load effects and fatigue effects.	**10**
CO4	Evaluate the capacity of the column subjected to combined axial compression and bending moment.	**20**
CO5	Calculate all the possible loads on the roof truss and its load combinations	**15**
CO6	Design the purlins & roof truss members using rolled steel sections.	**10**

*** Weightage depends on Bloom's Level, the number of contact hours.

CO Mapping with CDIO Curriculum Framework

CO #	TCE Proficiency Scale	Learning Domain Level			CDIO Curricular Components (X.Y.Z)
		Cognitive	Affective	Psychomotor	
CO1	TPS3	Apply	Value	Mechanism	1.1.1, 2.1.1, 4.4.1,3.2.5 , 4.4.2, 4.4.3,
CO2	TPS3	Apply	Value	Mechanism	1.1.1, 2.1.1, 4.4.1,3.2.5 , 4.4.2, 4.4.3,
CO3	TPS3	Apply	Value	Mechanism	1.1.1, 2.1.1, 4.4.1,3.2.5 , 4.4.2, 4.4.3,
CO4	TPS3	Apply	Value	Mechanism	1.1.1, 2.1.1, 4.4.1,3.2.5 , 4.4.2, 4.4.3,
CO5	TPS3	Apply	Value	Mechanism	1.1.1, 2.1.1, 4.4.1,3.2.5 , 4.4.2, 4.4.3,
CO6	TPS3	Apply	Value	Mechanism	1.1.1, 2.1.1, 4.4.1,3.2.5 , 4.4.2, 4.4.3,

Mapping with Programme Outcomes and Programme Specific Outcomes

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

S- Strong; M-Medium; L-Low

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	-	-	-	-	-
Understand	20	20	50	50	20
Apply	80	80	50	50	80
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Assignment/Practical Component
Perception	-
Set	-
Guided Response	50
Mechanism	50
Complex Overt Responses	-
Adaptation	-
Origination	-

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

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):

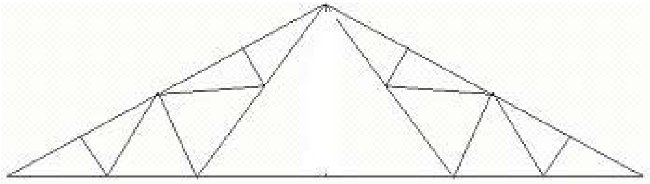
1. Design a gantry girder without lateral restraint along its span, to be used in an Industrial building carrying over head traveling crane for the following data:
   i. Centre to centre distance between columns = 6 m (span of the gantry girder)
   ii. Crane capacity = 50 KN
   iii. Self weight of the 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. A fink roof truss is proposed to be constructed at Chennai. The pitch of the roof is $^{1}/_{4.5}$ for a span of 20m. The trusses are spaced at 4.5m c/c. use GI sheeting. The height of the roof above the ground level is 12m. The configuration of the girder is given in figure-



2. The following are the critical loads. Use Fe 410 grade steel. ISMC 150 purlins are placed only on the nodes. The truss is supported on a RCC column of size 450 x 450 mm of M30 grade concrete. Design the ridge connection and the base connection.

Members	Critical Forces in Kn	
	Compression	Tension
Principal Rafter	85	65
Tie Member	65	97.5
Main Sling & Main Strut	30	33.5
Minor sling & Minor Strut	22.5	24

3. How Channel purlin will behave in DL+LL and DL + WL load combinations?
4. Design a channel purlin for fink type roof truss using the following data:

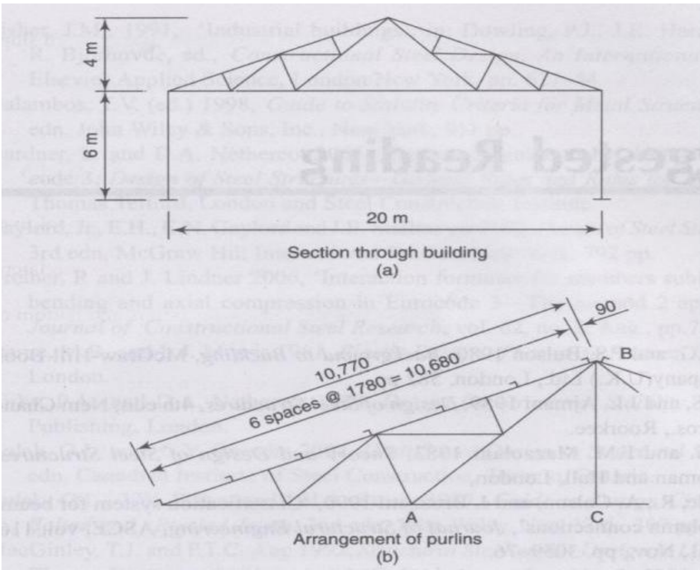
   Spacing of roof truss - 4.5 m

   Spacing of purlin along sloping length - 1.4 m

   Maximum DL = 5kN (C) ; LL = 3kN (C) and WL= 11kN (T)

Course Outcome 5 (CO5):

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).



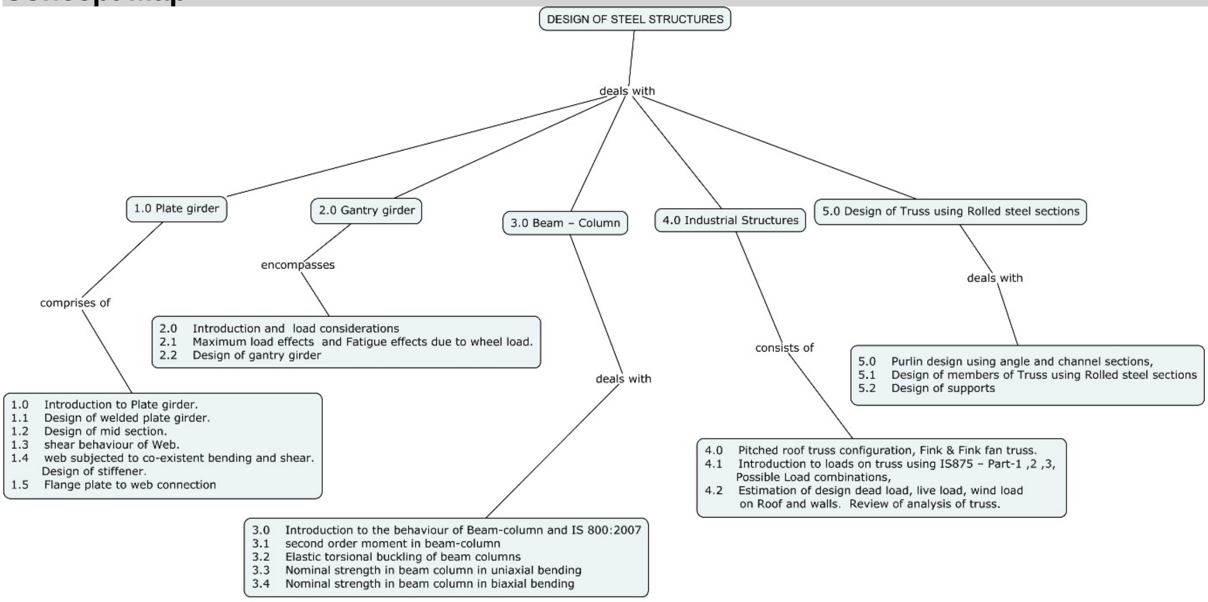
2. List out various elements of the roof truss and mark all its significance.
3. Estimate the capacity of the tubular principal rafter subjected to a compression of 125kN and a tensile force of 80 kN under the reversal effect. The member also subjected to a bending effect of 15kN-m under DL+LL and 9kN-m under DL+WL. Use Yst240 (Yst25)

Course Outcome 6(CO6):

1. Evaluate the bolted web cleat connection between a main beam ISMB300 and a coped beam of size ISMB250 which transfers a load of 50kN maximum reaction. Use M16 bolts of Gr.8.8.
2. Explain the force transfer mechanism of top and seat connection.

3. Evaluate the bolted top and bottom seat connection between a main beam ISMB400 and a column of size ISMB500 which transfers a load of 200kN maximum reaction. Use M16 bolts of Gr.8.8

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. **Industrial structures**: Pitched roof truss configuration, Fink & Fink fan, Introduction to loads on truss using IS875 – Part-1 ,2 ,3, Possible Load combinations, Estimation of design dead load, live load, wind load on Roof and walls. Review of analysis of truss. **Design of Truss using Rolled steel sections**: Purlin design using angle and channel sections, design of truss member against tension and compression, design of Support.

Indian Standard Codes

1. IS: 800 – 2007, Code of Practice for general construction in steel, BIS, New Delhi
2. SP 6 (1) – Structural steel sections
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.
6. IS: 808 – 1989 Dimensions For Hot Rolled Steel Beam, Column, Channel and Angle Sections.

Learning Resources

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. Gaylord E H, Gaylord N C and Stallmeyer J E, “Design of Steel Structures”, 3rd edition,

McGraw Hill Publications, 1992.
4. Salmon, Johnson & Malhas," Steel Structures: Design and Behavior, 5th Edition, Pearson
5. Negi L.S. "Design of steel structures" McGraw Hill Co., New Delhi, 2014
6. Duggal S.K., "Limit state design of steel structures" McGraw Hill Co., New Delhi, 2014
7. www.nptel.ac.in
8. http://www.steel-insdag.org/TM_Contents.asp

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	Course Outcome
	Plate girder		
1.0	Introduction to Plate girder – Difference between beam and plate girder & IS 800-2007.	1	CO1 & CO2
1.1	Design of welded plate girder	2	
1.2	Proportioning of web and flange plates – Design of mid-section		
1.2.1	Curtailment of flange plates	1	
1.3	shear behaviour of transversely unstiffened and stiffened web	2	
1.4	web subjected to co-existent bending and shear	2	
1.4.1	transverse web stiffener – Bearing stiffener	2	
1.4.2	End-bearing stiffener and load-bearing stiffener	1	
1.4.3	Longitudinal web stiffener	1	
1.5	Flange plate to web connection	1	
1.5.1	Splices - Flange and web	1	
	Gantry girder		CO3
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 to vertical component of crane wheel load	1	
2.1.2	Determination of maximum bending moment and shear force due to 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	1	
	Beam-Column		CO4
3.0	Introduction to the behavior of Beam-column and IS 800:2007	1	
3.1	Second-order moment in beam-column	2	
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	2	
	Industrial structures:		CO5
4.0	Pitched roof truss configuration, Fink & Fink fan truss.	1	
4.1	Introduction to loads on truss using IS875 – Part-1 ,2 ,3, Possible Load combinations,	2	
4.2	Estimation of design dead load, live load, and wind load on Roof and walls. Review of analysis of truss.	2	
	Design of Truss using Rolled steel sections		CO6
5.0	Purlin design using angle and channel sections,	2	

5.1	Design of members of Truss using Rolled steel sections	2	
5.2	Design of supports	2	
	Total Hrs.	36	

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